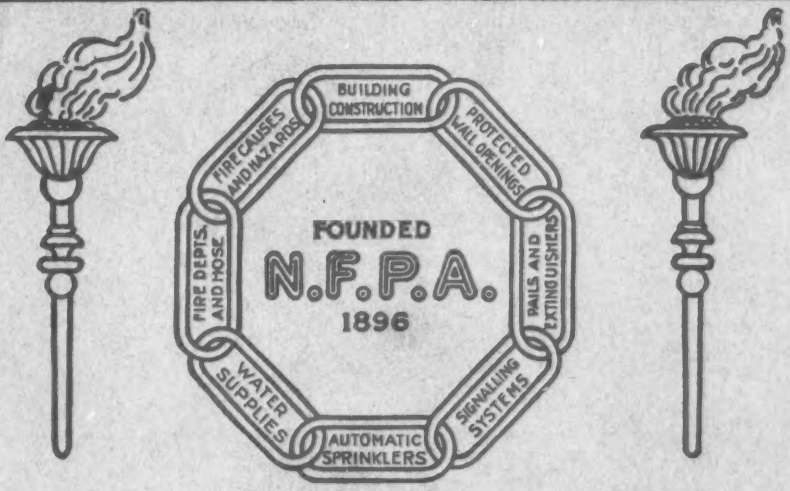
Vol. 30 APRIL, 1937 No. 4

QUARTERLY
OF THE

NATIONAL FIRE PROTECTION ASSOCIATION



"To Promote the Science and Improve the Methods of Fire Protection and Prevention."

PUBLISHED QUARTERLY AT BOSTON, MASS., BY THE
NATIONAL FIRE PROTECTION ASSOCIATION

Printed in U. S. A.

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Vol. 4 No. 1

Vol. 30 April, 1937 No. 4

QUARTERLY

OF THE

National Fire Protection Association

Subscriptions are accepted only from members of the Association and are charged as a part of the annual dues. Membership is open to anyone interested.

Entered as second-class matter December 15, 1928, at the Post Office at Boston, Mass., under act of March 3, 1879.

60 BATTERYMARCH STREET, BOSTON, MASS.

National Fire Protection Association.

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Printed in U. S. A.

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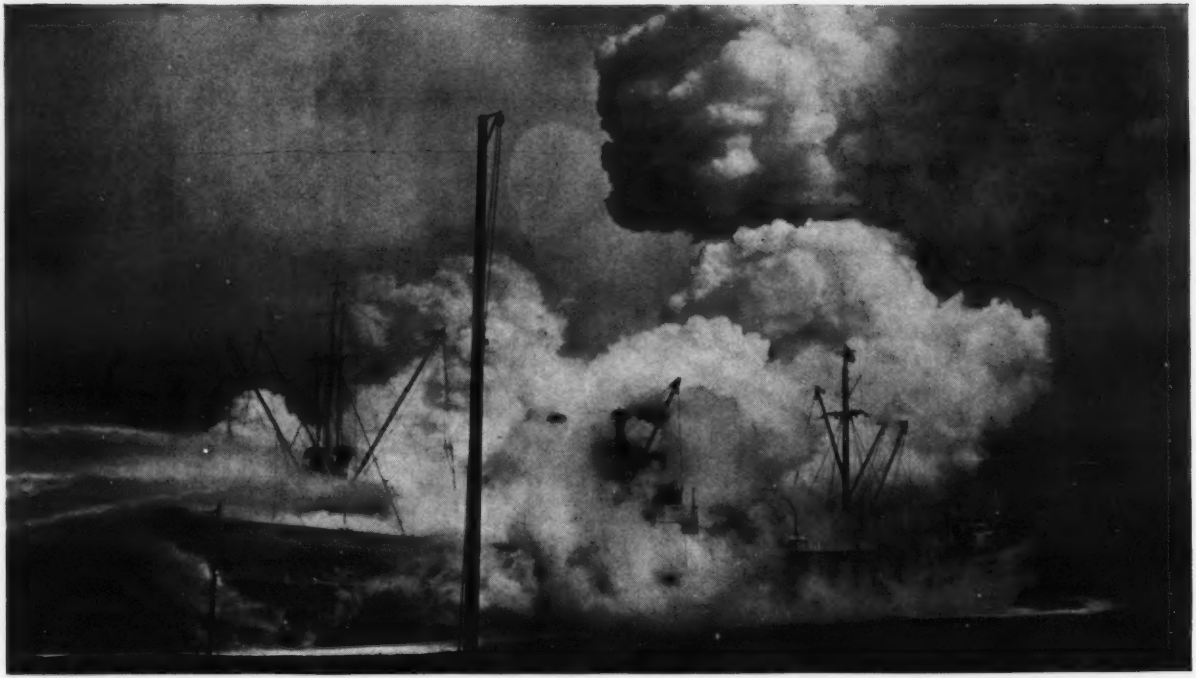


Pictures, Inc.

This fire started in a forward hold of the new Danish freighter "Laila" at the Charlestown section of Boston harbor on the morning of March 10, 1937. The fire started in a bag of sodium nitrate, presumably due to a metallic spark from a bucket hoist used in unloading. In addition to the nitrate in bags and in bulk, the vessel carried beans, garlic, lentils, and iodine. Violent explosions accompanied the fire, which wrecked the forward part of the vessel. The fire was drowned out by heavy streams from three fireboats and 27 pumpers which delivered upward of 35,000 gallons of water a minute on the $300,000 blaze.

The Quarterly

Vol. 30 April, 1937 No. 4

The London, Texas, School Disaster. The school tragedy in London, Texas, reported in this QUARTERLY, represents the largest single loss of life by fire in recent years. While this case was a gas explosion with no ensuing fire, an explosion of this kind is considered by fire protection authorities as in the same class with a fire, as it was essentially combustion of a mixture of gas and air which was responsible. There is no sharp dividing line between a fire and an explosion; the difference in the results is only a matter of rapidity of combustion.

This disaster again serves to emphasize the importance of life safety as the first purpose of all measures of fire prevention and fire protection, particularly in structures where large numbers of people congregate. Prevention of property loss is so largely the concern of fire protection authorities that the primary importance of saving lives is sometimes overlooked; this consideration should always be uppermost in all planning of measures of fire prevention and fire protection. There is a double reason for emphasis on the fire safety of schools. In addition to the public responsibility for safeguarding children from unnecessary hazard, there is the fact that children are by law required to go to school. People who feel that commercial or industrial buildings are fire traps are free to follow their own judgment in avoiding exposure to danger, but children and their parents have no option in the matter of school attendance, and for this reason the public authorities have a responsibility to insist upon the highest degree of fire safety which it is possible to attain.

The building involved in this explosion was a modern structure of a type popularly regarded as "fireproof." The disaster was due not to the same defects of construction and arrangement which have been responsible for previous school fire tragedies, but to the neglect of proper precautions in the installation of gas piping. The National Fire Protection Association has long recognized this hazard and has established recommended good practice regulations for safeguarding it. Where these recommendations are followed, such hazards are largely eliminated.

The court of inquiry in this case exonerated the school officials. They had no knowledge of the danger to which they were exposing the children under

their care. While the school officials in this case were exonerated of any legal responsibility, it seems clear that public administrators responsible for the safety of the lives of school children should be morally responsible for observing all known safeguards against every type of fire and explosion hazard in so far as it may be in their power to do so. Ignorance of a danger does not excuse neglect of proper precautions, particularly where published information is available which points the way towards eliminating hazards and which is available to anyone for the asking.

* * * * *

The 41st Annual Meeting. Returning to Chicago after an absence of ten years the Association finds the scope of its activities now so increased that a five-day convention is necessary to complete the business of the meeting, after years in which three or four days were sufficient. Fire is a problem in every type of business and manufacturing; almost every kind of equipment used in industry, in homes and in public buildings is of direct or indirect concern to the fire protection engineer; methods of fire extinguishment and measures for the reduction of incidental fire damage have wide ramifications. With the rapid movement of our civilization, every year there are new aspects of the fire problem that must be considered from the technical point of view as well as the constantly recurring consideration of public education, legislation, and the humanitarian and economic aspects of the fire waste.

Our sister organizations confronted with the problem of considering a wide variety of subjects in a short convention period have largely adopted the expedient of holding simultaneous sessions on different topics. Similar proposals have been made for the N.F.P.A. meetings, but have been discarded because of the wide range of the interests of so many N.F.P.A. members, who in a program of simultaneous sessions on different topics would perforce miss some items of very real interest to them. It is this very breadth of interest in so many different subjects that makes the N.F.P.A. a unified and coherent organization despite the diversity of its field.

The Chicago meeting, in a convenient central location, has a program that should attract a large and representative group of the Association membership, and will offer many items of real interest and value to every one concerned in any phase of the broad field of fire safety.

* * * * *

Criticizing the Firemen. It is very easy for spectators at the scene of a fire to criticize firemen. The sidewalk expert, well away from the smoke, heat and poisonous gases, can easily see how the fire might have been better handled by some other method. The man on the sidewalk may have no understanding of the conditions and does not realize that in a church fire, for example, the firemen in order to ventilate the building and prevent a

total loss, may have to break a stained glass window. What the man on the street sees is apparently wanton destruction of a valuable window. This sort of criticism is rightly resented by fire departments, particularly where such unintelligent criticism is given publicity.

To offset such criticism, other spectators regard all firemen as heroes, as saviors of life and property who can do no wrong.

Constructive criticism seems to be rare. Unthinking hero worship and captious criticism that sees every fault are perhaps equally undesirable. There is a type of intelligent and constructive criticism by men who understand problems of fire fighting that is welcomed by progressive chiefs and fire department officers who realize that firemen, like men engaged in any other line of activity, are only human, that they make mistakes and may be able to learn something from criticism made in a friendly and constructive way.

Acme.

A spectacular fire in a truckload of grain on a California highway. The truck and contents were destroyed in the intense fire before aid could be summoned. About all the driver could do was detach the accompanying trailer, which saved half his load.

Meeting of Board of Directors.

Atlantic City, January 16, 1937.

Present.

Albert T. Bell, Chairman
George W. Elliott, President
S. D. McComb, Vice-President
Harold L. Miner, Past President
Sumner Rhoades, Past President
Franklin H. Wentworth, Managing Director
H. T. Cartlidge
A. O. Dawson
Russell Grinnell
W. F. Hickey
C. W. Johnson
A. H. Kehoe
W. E. Mallalieu
F. T. Moses
S. L. Nicholson
David J. Price
A. R. Small
Richard E. Vernor
John L. Wilds

There were also present Percy Bugbee, Assistant Managing Director, and Robert S. Moulton, Technical Secretary.

Business Transacted.

1. The program of the 41st annual meeting was discussed.

2. A verbal report from the Chairman of the Finance Committee was received.

3. The President presented a resolution on the death of Charles W. Mowry which was adopted by a rising vote.

4. John S. Neale of Chicago was appointed a member of the Nominating Committee to fill the vacancy left by the death of W. D. Grier.

5. A. L. Brown of Boston was appointed a member of the Automatic Sprinkler Ordinance Committee to replace C. W. Mowry, deceased.

6. Verbal reports from the Executive Office staff were received on the items of Membership, Publications, Advertising, Field Service and Volunteer Firemen's Section.

7. The status of the New York City Committee was discussed and it was voted the sense of the Board that contacts on local subjects can be satisfactorily decided as specific situations arise, it being understood that no contacts will be made by the New York City Committee until concurred in by the Board of Directors of the N.F.P.A. either directly or through its Managing Director.

8. Board member A. R. Small made an informal report as the N.F.P.A. representative in the American Standards Association.

Technical Committee Affairs.

9. The report of the Committee on Technical Committee Procedure was considered and approved, including action on the following items:

Committee Personnel.

The changes in and additions to technical committees made between the meeting of the Board in June, 1936, and the publication of the Year Book were approved.

The committee's action was approved in respect to taking no action on requests of the National Electrical Manufacturers' Association for representation on the Committee on Flammable Liquids and for various additions to the Committee on Blower Systems, and a suggestion by Mr. C. W. Gustafson that the Electrical Committee be represented on various other committees.

It was voted to approve the committee's recommendation that the requests of the following organizations for representation on the Electrical Committee should not be approved:

International Association of Governmental Labor Officials

International Association of Industrial Accident Boards and Commissions (additional representative)

International Brotherhood of Electrical Workers

Scope Statements.

The revised scope of the Committee on Electric Railway Car Houses and Cars was approved as printed in the 1936 Year Book.

The name of the Committee on Small Hose Couplings was changed to "Committee on Hose Couplings and Nozzles," and its scope to: "The design of hose couplings, nozzles and accessory equipment for fire protection use."

A.S.A. Matters.

The plan of organization of the Committee on Building Code Requirements for Fire Extinguishing Equipment was approved, including the policy of adopting existing N.F.P.A. standards by reference rather than duplicating their requirements, and the policy of confining this project to the common types of protection usually covered by building codes rather than extending it to special types of protection for special hazards.

Submission of paragraph 2012 of the Building Exits Code to the American Standards Association in the form adopted by the Board at its June, 1936, meeting was approved in accordance with the view of the committee that this paragraph is not inconsistent with A.S.A. Resolution No. 2573.

Action of the committee in declining to participate in the revision of the Elevator Safety Code was approved.

Committee Appointments Confirmed by the Board.

Blower Systems.

C. A. Booth, National Association of Fan Manufacturers.

Building Code Requirements for Fire Extinguishing Equipment.

C. W. Johnson, Committee on Automatic Sprinklers.

A. G. Smith, Committee on Field Practice.

Franklin H. Wentworth, Committee on Laws and Ordinances.

Electrical.

I. V. Goodman, Association of American Railroads (formerly alternate).

W. H. Greenlaw, National Municipal Signal Association (replacing C. S. Graham).

A. E. Pringle, National Electrical Manufacturers Association (replacing T. E. Barnum).

Farm Fire Protection.

A. O. Boniface, Chemical Fire Extinguisher Association (replacing B. F. Allnutt).

Fireproofing and Preservative Treatments.

M. P. Mason, Conference of Special Risk Underwriters.

Forest.

Robert Marshall, Indian Bureau (replacing J. P. Kinney).

Spence D. Turner, Member at Large.

Protection of Openings in Walls and Partitions.

W. K. Estep, Middle Department Rating Association (replacing R. J. Trimble, deceased).

Public Water Supplies for Private Fire Protection.

J. Walter Ackerman, American Water Works Association (replacing Nicholas S. Hill, Jr., deceased).

Spontaneous Heating and Ignition.

A. A. Blowski, Sugar Industry.

Truck Transportation.

D. C. Fenner, Truck Manufacturers.

10. The Committee on Motor Craft of the Marine Section submitted drafts of Sections 10(*e*), 10(*f*), 10(*g*) and 11 of subject "Galley Stoves," and Section 13(*h*) of subject "Electrical Equipment" as amended subsequent to June 25, 1936, with the request that they be approved for incorporation in the finally adopted Appendix D of N.F.P.A. Marine Regulations. After discussion the drafts were referred back to the Committee on Motor Craft, with request to consider the suggestions made by Board members Small and Moses and report to the Committee on Technical Committee Procedure which was authorized to approve the amended drafts.

11. The special committee of the Board, consisting of members Small, Elliott, Kehoe and Nicholson, which was requested to give further consideration to its original opinion submitted to and adopted by the Board on the matter of safeguarding electrical transformer vaults, reported as follows:

> As requested, the committee has given further consideration to the report which it made to the Board at the meeting of January, 1935, relative to the scope of the National Electrical Code and with respect to the question — Does the scope of the Code include requirements agreed upon within the Electrical Committee for vault location, construction, and equipment that will safeguard persons and property within the premises where the vault is located or exposed thereby? It is the committee's view that the scope is properly interpreted in the affirmative with respect to the question.

It was voted to adopt the report and endorse its conclusion as the view of the Board.

12. **Communications.**

(*a*) In response to its letter of January 6, 1937, the Managing Director was instructed to inquire of the Bureau of Standards if the proposed revision of the National Electrical Safety Code is to include Part 3 and to advise the Bureau that if Part 3 is not to be included the Fire Protection Group will not desire representation upon the sectional committee.

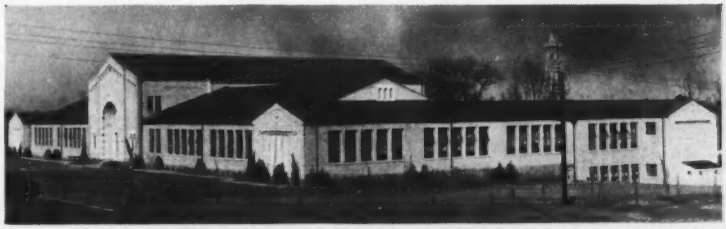
(*b*) A communication from the AutoFYRstop Company to the President dated January 6, 1937, was received.

(*c*) A communication dated January 11, 1937, was received from Fire Marshal Sherman V. Coultas of Illinois, Chairman, Fire Marshals Section, N.F.P.A., requesting the preparation of a model law for the guidance of states in the control of electrical hazards. On motion of Board member Miner, the Chairman was requested to appoint a committee to draft such a law to be presented to the Association by the Committee on Laws and Ordinances.

The London, Texas, School Disaster.

By H. Oram Smith,
Texas Inspection Bureau.
(Member N.F.P.A.)

A gas explosion that caused the death of 294 school children and teachers, resulting in one of the major disasters of the present century, occurred in the East Texas oil field district about 3:15 P.M. on March 18, 1937. The site of the explosion was the unincorporated community of London, about four miles east of the little town of Overton in the northwest corner of Rusk County, ten miles from Henderson, Texas. The community consists principally of the school property of the London Independent School District, Inc., comprising the large high school building, several smaller buildings and seven active oil wells owned by the school district. Beyond the school property on all sides were oil well derricks, gas flares, and a distant refinery, all typical of the oil field industry. Because of the wells on its property it had the unique distinction of being about the wealthiest rural school district in the world, catering largely to families of the oil field workers over a territory as much as 15 miles distant in several directions.



The London, Texas, Consolidated High School was a building of modern construction. This picture is taken from the southwest.

The blast occurred with the suddenness characteristic of such explosions, although with some unusual features. Every witness agreed that there was but one explosion and that it was a low rumbling noise, with none of the blast or roar that might be expected. Yet there is evidence of a most terrific force in the great extent of devastation and loss of life that came almost instantly; testimony of bodies tossed 75 feet into the air; an automobile 200 feet distant crushed like an eggshell under a two-ton slab of concrete that had been hurled from the building. And as a further evidence of the terrific force, the established point of origin indicates that the explosion had to break through an 8-inch concrete floor slab before starting on its path of destruction. Many of

the children in rooms directly above this point were literally blown apart or mangled beyond recognition.

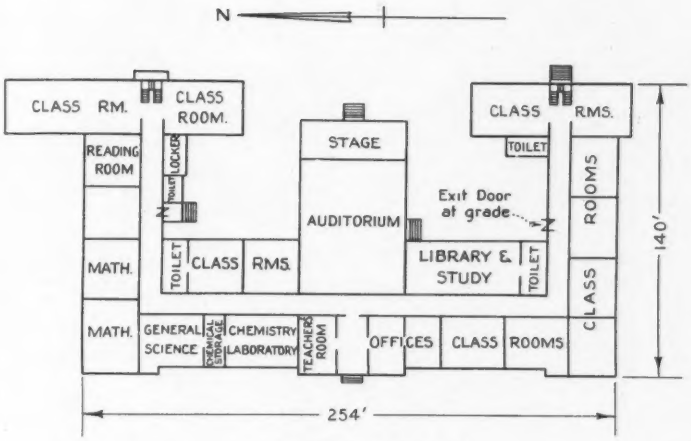
There was very little of the structure left standing after the blast and most of that had to be pulled down to prevent falling after the débris was removed, which was practically overnight. From the earliest photographs taken, the blast seems to have completely demolished the entire front section, 58 by 254 feet, both the north and south wings back to the east 25-foot additions, and the center auditorium wing back to the last 40 feet of the east end, which had to be razed when the supporting wreckage was removed. All that remains of a $300,000 modern school plant is a badly wrecked two-story addition forming the rear of the north wing which will have to come down and a few broken walls where a similar addition completed the south wing.

The facts and conclusions presented in this report were reached after a careful survey of the grounds and from evidence brought out at the military court of inquiry where the writer was accorded full courtesy. We were under a heavy disadvantage, however, in two main essentials; a majority of the important witnesses were the bereaved parents, relatives or friends of the dead, still under the influence of shock and hysteria; some even feared that blame or censure was intended. The immediate removal of all wreckage to recover bodies destroyed what would have offered valuable evidence. The removal of this débris is worthy of comment since it is probable that in no past disaster of record has it been approached in speed or efficiency, and nowhere but in the oil fields would it have been possible to find the necessary equipment, labor and experience immediately available. In the short space of 17 hours after the work was organized, some 2000 tons of débris were picked up piecemeal and hauled away during an all night rain storm; concrete slabs were broken up, tangled steel cut with torches and the smaller fragments that had to be shoveled were carried off in small baskets and carefully emptied under flood lights to avoid overlooking a hand or foot or any torn portion of a body.

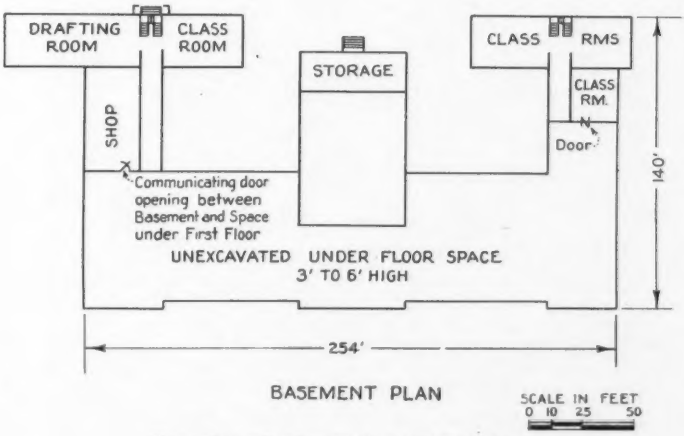
Construction and Occupancy.

The school property is a consolidation of the London and New London districts, covering a number of acres over portions of two farms, and comprises a group of widely detached buildings of both brick and frame construction for grammar school, gymnasium, band room, domestic science, etc., in addition to the large high school and auditorium building which was the only one involved in the explosion.

The high school was erected in 1932 with additions in 1934; it was built on ground sloping in two directions, with a down grade from north to south and from west to east. The main section was 58 ft. wide and 254 ft. long, fronting west, with classrooms on each side of a 10-foot central corridor. At the north and south ends, wings extended east to a depth of 136 ft., terminat-



FIRST FLOOR PLAN



BASEMENT PLAN

SCALE IN FEET
0 10 25 50

Plan of the London High School Building.

International.

After the explosion which took 294 lives. Only portions of the east wings were standing. This picture shows the oil field workers engaged in removing the wreckage to uncover the corpses of the victims.

ing in two-story "T" additions. Directly in the center the two-story auditorium section formed another wing extending east 115 ft. The whole plan formed a letter "E" and covered nearly 30,000 sq. ft. of ground area.

The main or front section was one story high on a concrete foundation wall all sides and on intermediate concrete piers, forming a concealed dead air space from 3 to 6 ft. high, varying with the uneven surface of the ground. The central auditorium had a two-story front as far back as the balcony, continuing as one high story of equal height to the rear stage wall. Both the north and south wings were carried back to a height of two stories, owing to the drop in grade; the second floor in each case being a continuation of the first floor of front section, while the lower floor, known as the basement, was actually on grade level and was the first floor in each of the rear wings. The building was of reasonably good construction, with walls of 4-in. brick backed with 8-in. hollow tile, mainly non-bearing; the loads were carried on steel I-beam columns and girders. The floor over the concealed space was an 8-in. reinforced concrete slab supported on concrete girders, foundation walls and concrete piers; the small area of second floor in each of the two wings was 3-in. concrete slab on steel and reinforced concrete girders. All floors had hard wood overlay on wood sleepers. The roof over the entire building was tile on a one-inch wood deck and 2 by 6 in. wood purlins on light fabricated steel trusses spaced 10 ft. on centers. All upper floor ceilings were metal lath and plaster hung from the steel trusses, forming open attics of 10 to 12 ft. high to the ridge. The rear first floor ceilings were concrete. The building was known as the high school and auditorium, but all portions south of the auditorium, including the entire south wing, were used by the higher grammar grades.

There were two rooms devoted to laboratory and science work, one having 12 laboratory tables, each of which had two ½-in. gas pipes carried up from under the floor with two bunsen burners on each line. These two rooms were located in the front of the main section near the north end of the building. A manual training shop was located in the lower floor of the north wing; it contained several machines driven by individual motors and one portable sander with a heavy cord and plug switch for a wall socket. This shop backed up against the 12-in. concrete foundation wall of the front or main section and communicated with the concealed floor space through a 4 by 4 ft. opening in the foundation wall, having a wooden door normally kept partly open. The shop and the sander, according to the evidence, played a very important part in the disaster as described later.

Heating and Ventilating.

The original plan called for a central steam heating plant, but was abandoned before construction started because of the higher cost as compared with individual gas stoves. A common type of gas-steam radiator was adopted after

The rear of the school, showing the east end of the three wings, the auditorium in the center. Owing to the slope of the ground, the building was two stories at this end.

the School Board members had consulted several people presumed to be familiar with the subject, including members of other school boards. The device has the appearance of an ordinary steam radiator, but is an individual heating unit comprising a gas burner at the base, under a small water chamber cast into the unit. Steam circulates through the hollow sections of the radiator and heats by radiation like the standard steam type. The burner is partly enclosed, but communicates with the outer air through a circular hole about an inch in diameter where a match can be inserted to light it. The unit is equipped with a small regulator at the gas supply end by which pressure may be adjusted, and has a safety valve or blow-off on the water chamber. It is a well-known make used extensively in the Southwest and is considered as safe as any gas heater on the market. It is used to a large extent without vents, but can be equipped with a vent pipe for a wall flue if desired. There were 72 of these heaters in the building and as there appears to have been some belief that the state school authorities required all classroom heaters to be ventilated, some effort was made to vent only those heaters located in classrooms. A short piece of threaded pipe extended from the vent outlet on the heater into the wall, neatly finished with a collar at the wall entrance, giving the appearance of a properly vented unit, but as there are no flues in the walls this supposed vent simply entered a hole punched into the wall tile.

Room Ventilation.

Room ventilation was mainly through windows on all sides, although two or three small wall vents were located in the rear two-story section. An important weakness in ventilation, however, was the totally inadequate provision for venting the concealed dead space under the main section of building where the destructive gas is presumed to have accumulated. This continuous concealed space had a superficial area of over 15,000 sq. ft. entirely enclosed by a 12-in. concrete wall, but having communicating doors opening into class-

The rear of the auditorium and south wing immediately after the explosion, before removal of wreckage had started. This picture is taken from the east, showing the damage on the side away from the main force of the explosion.

rooms of both the north and south wings. The depth of this space varied from two or three feet to as much as six feet at some points. A conservative estimate of three-foot average depth means about 46,000 cu. ft. of dead space for which only four small 12 by 24-in. vents were provided. Two of these vents were at the north and south ends, 254 ft. apart, and two on the east wall where the distance and angle to the opposite ends could not give proper circulation.

Gas Fuel and Pipe Lines.

A great deal of publicity was given to the fact that the school officials had discontinued the use of commercial gas from the utility company that had been costing as much as $250 a month, and had tapped a free gas line of "wet" or "residue" gas from a gasoline extraction plant without permission. This is a point that requires some explanation of a common practice that the school officials adopted with good intention.

When an oil well is brought in, it flows under its own gas pressure. This gas is separated from the oil and piped off to some distant point and burned in a flare. It usually has a heavy gasoline content and in some locations gasoline companies set up extraction plants to which this gas is piped, the gasoline extracted and the residue gas piped back to the lease from which it came. This procedure follows a standard form of contract; the gasoline company has no authority to sell or dispose of the residue gas, neither can they give permission for anybody to tap the line, although the gas is headed back to an open flare to be wasted. There appears to be an obligation on the gasoline company to serve notice of disconnection should they "find" the line tapped, but as a matter of inclination and general custom they are willing to look the other way until the line is covered. It is therefore a common practice for churches, schools and even private homes to get this free gas if within reach of the pipe line. While the gasoline has been extracted, it is still known as "wet" gas; it

is more or less unstable as to volume, and pressure fluctuates considerably; it contains impurities that are removed in commercial gas. Apart from the inconvenience of keeping the heating units adjusted to the irregular supply and pressure, there is no particular hazard in its use as compared with ordinary commercial gas which has caused similar explosions.

This gas supply reached the building through a 2-in. pipe into a gas regulator of standard commercial type located outside the south wall. It had a capacity of 50 lbs. on the high pressure side reduced to 5 oz. on the domestic supply side. The average pressure on the extraction plant residue line was said to be 25 lbs. From the regulator the 2-in. line entered and extended in a full circulating loop under the entire concealed space of the main section of the building, suspended by metal straps from the concrete slab forming the first floor. Numerous 1½-in. lines extended up to the room heaters from this line. Other 2-in. lines were carried to the rear of the two-story wings and extended through the attics, with drop lines to the heating units on the two floors below. As all gas pipe involved in the area of explosion was blown away, it was impossible to trace the leak or leaks that undoubtedly existed. It developed, however, that all repairs and extensions to gas or water lines, electric wiring, etc., were made by one of the school janitors who were jacks of all trades and probably masters of none. They may have neglected to test the pipes for pressure leak before turning the gas in; failed to pull the threaded joints up tight; omitted to apply lead or other compound at the joint, or even cracked a pipe without knowing it. There is no evidence to indicate observance of the N.F.P.A. Recommended Good Practice Requirements for the Installation, Maintenance and Use of Piping and Fittings for City Gas.

Development of Evidence.

There were rumors that the explosion was due to nitroglycerine or dynamite. Dynamite was being used at the athletic field in the construction of a running track. One of the teachers testified that when he heard the explosion he thought it was another shot at the field. It was also found that 18 sticks of dynamite were stored in a lumber room under the auditorium stage and went through the explosion intact. By the process of elimination it became obvious that the cause of the explosion was the ignition of a large pocket of gas in the large improperly vented space under the floor. This theory was corroborated by evidence of the heavy concrete floor slab above the space being blown up from below, and testimony that bodies, desks and lockers were found on the bare ground, indicating that the slab floor had been blown out before the bodies and other objects fell.

It appeared most probable that the gas was ignited in one of the rooms where laboratory or shop work was conducted in the northwest corner of the building. The shop where most of the electric devices were used adjoined and

Wreckage of the auditorium section looking toward the stage.

communicated with the under floor space at this point. Progressing further on this theory it appeared that there should be two classes of dead; those in the immediate path of the blast, who should show evidence of burns and mutilation, and those killed by falling wreckage. This line of investigation developed the fact that all bodies with evidence of burns or with arms and legs blown off and missing came from classes in the northwest rooms and that the worst case of burns was the teacher who was just starting a class period in the woodworking shop. One of these shop pupils who escaped with slight injury testified that the door into the adjoining concealed space was about half open, that the electric switches and wall sockets were within two feet of the open door on the same wall, and that the teacher was in the act of plugging in a portable connection to the sander when the flash and explosion followed.

Explosive Gas Mixture Under Floor.

This practically established the fact that the large under floor space of the main section was pretty well saturated with an explosive mixture of gas and air from a source of gas leakage that will never be determined. Some of this gas

mixture passed the open door into the shop and was ignited by an arc formed when the two prongs of the portable switch touched the socket before it was driven into place. The resulting flash followed the gas back under the building, creating the superheated gas and pressure necessary to blow the building up. While the northwest corner of the building was blown out first, there was no appreciable interval in the collapse of other portions. The blast traveled the entire 254 ft. of building instantly and literally blew it to pieces. Witnesses testified that the roof was lifted at one corner at the same time that walls were blown out at another corner.

The theory of released gas from the oil fields floating into the premises was discounted by the fact that the building is located on high ground, while floating gas would be confined to the lower levels. The U. S. Bureau of Mines engineers drilled all over the school campus and found no seepage of gas from any underground source. The question of using the residue or wet gas had no bearing, since any leaking gas under the same circumstances would produce the same result. The much publicized theory of accumulated gas in the hollow tile walls was started through ignorance of the conditions. There was no way in which free gas could enter the walls. Furthermore, it was not a wall explosion. The question of faulty gas heater vents was discussed at the court hearing as well as in the press comments and while the whole question of the heater installation is subject to criticism, it had no bearing on the explosion.

The only point of attack on the conclusion of accumulated gas in the under floor space was the testimony of one of the janitors that he had entered that space at 10 o'clock that morning, 5 hours before the explosion, and had lighted matches to smoke and find his way about in the dark; indicating that there was no gas leaking at that time. This is conceded to be possible, as his point of entry was at the extreme south end of the building and his travel distance not over 50 ft., according to his own evidence. He was therefore about 200 ft. away from the area where the explosion originated and gas might have been leaking at the north end of the building without reaching an explosive mixture 200 ft. away. Furthermore, with the great amount of gas pipe and fittings up to two inches in size, it would have been possible for a leak to start after his departure, and form an explosive mixture in much less than five hours.

No Fire Following Explosion.

No fire followed the explosion, presumably due to the small amount of combustible material. The main structure was of concrete steel and tile as previously described. The windows were metal factory sash. Apart from the interior wood trim at the doors and the furniture, everything was practically non-combustible up to the wooden roof deck. This roof deck was covered on the outside with tile and was cut off from the interior by metal lath and plaster ceilings.

The Loss of Life.

While early reports put the total casualties at a larger figure, the final count shows that the deaths totaled 294, including 120 boys, 156 girls, 4 men teachers, 12 women teachers, 1 woman visitor and a 4-year-old boy visitor. At this writing there are still 39 injured in hospitals; it is reported that all of these will recover.

There is no record of the total number of persons in the building at the time of the explosion, but it appears that the majority of the occupants were killed or injured, and that practically all of those in the main part of the building were killed at once or were fatally injured.

Those who survived were in the wings, mostly on the upper floor. There are many reports of jumping from windows, which appears probable, as the windows were not more than 10 ft. above the grade. There were three boys who were in the shop where the explosion originated who escaped with slight injuries. They were in the far end of the room and were blown into the rear addition.

There were many reports of persons who survived by reason of protection of desks and other objects of furniture. It is probable that some children and teachers crawled under desks, but it appears doubtful that there was enough time for any teacher to direct an entire class to get under their desks. The survivors who were immediately able to get out were assisted from under the wreckage in conditions varying from slight shock to broken limbs or fatal injuries. Many were pinned under the wreckage for long periods and were released only when heavy material was lifted by the use of jacks.

Conclusions.

It has been established beyond reasonable doubt that the explosion was due to leaking gas from a pipe or pipes under the building, and that ignition was from the arc of an electric switch in the manual training room at the moment that the teacher plugged a portable connection into a wall socket close to the open door. The court of inquiry exonerated all school officials of personal blame; no one individual was responsible. It was the collective faults of average individuals, ignorant or indifferent to the need of precautionary measures, where they cannot, in their lack of knowledge, visualize a danger or hazard.

The school building was of good construction and planned for reasonable safety except for the gas installation. The excessive area of concealed space under the building was poor practice for a building of this type and occupancy, but not necessarily a structural weakness in itself. When bottled up without ventilation, however, and filled with gas pipe lines and electrical circuits, it became a serious fault. The four small vents were just about what

would be required for a six-room cottage; they were not only too small and too few, but were so far apart that they could not create circulation.

The use of numerous separate heaters with gas fuel lines extending all over the building was a subject of severe criticism. Many of these units had been disturbed by teachers or students for various reasons; they had been moved by pulling the free end away from the wall, putting a strain on the fixed gas connection. When burners got out of adjustment and flared up, a teacher or one of the older boys became a self-appointed fixer. The first principle of safety requires that all hazardous devices in school buildings be made proof against tampering or interference.

This method of heating was entirely wrong and in combination with the unventilated floor space was responsible for the explosion. The difference in cost of a properly cut off steam heating plant should never be considered where the lives of many school children and teachers are involved.

While the gas heater vents did not contribute to the disaster, the evidence showed a disregard for the hazard of non-ventilated gas fires in crowded school rooms. In this respect, the school officials, architects and heater salesmen were equally at fault. The few attempts to ventilate into the dead space of a blank wall where no flues existed, were obvious deceptions to cover up an omission. It is hardly conceivable that the practical men involved in this installation could have considered such makeshifts as filling the requirement for ventilation.

Inexpert Workmanship on Gas Piping.

The original electrical and plumbing installations were made by contractors of presumed qualification, but many alterations, repairs and additions, including the installation of the residue gas supply line, were made by one of the janitors. They were no doubt good workmen, experienced in a variety of oil field jobs, who were well recommended, but were not qualified electricians or gas fitters. Evidence of poor workmanship on some remaining electrical extensions suggests the probability of similar faults in the installation of gas lines. In the handling of gas and electrical work, where a small fault can produce dire results, school officials should call upon trained workmen at least to supervise such installations.

The use of residue gas from the gasoline extraction plant was not a matter of major importance, as ordinary commercial gas under like circumstances would have produced the same result. While the pressure on the discharge pipe line from the plant was not under regulated control, the school regulator reduced it to the customary safe level and there was no evidence to support the rumor that a gas line had blown out. Its use, however, is considered poor policy for a school property where so many separate heating units had to be frequently adjusted because of variation in pressure and quality of the gas.

The value of a distinctive malodorant in all gas supply systems by which leaking gas may be readily detected, is clearly evident. It is especially important in or adjacent to oil field territory where a leak might not be detected, owing to the constantly prevailing odor of petroleum gas common to those sections.

Practically all faults of construction and installation in this building were due to lack of supervising power such as would apply in communities having city ordinances. It serves to focus attention to the need of state laws on standards of construction, as well as approved standards for the installation of heating systems, electrical equipment, gas and oil systems and all features affecting the welfare of the public in schools, public buildings and all other buildings where large numbers of people congregate.

Volunteer grave diggers preparing for the mass burials.

Wooden Shingle Roofs.

A Survey of the Present Picture in the United States.

According to the present records of the National Fire Protection Association there are in the United States 534 municipalities that by ordinance prohibit wooden shingle roofs throughout their city limits. These cities include 27,570,000 people, or 22% of the national population. Among the large cities of the country included in this class are New York, Chicago, Philadelphia, Boston, Baltimore, New Orleans, San Francisco and Indianapolis. In a few of the cities in this classification wood shingles may be permitted in outlying sparsely settled districts, but to all practical purposes from the fire hazard standpoint they are not a factor.

In addition to this large group of cities which prohibit or practically prohibit wood shingle roofs, there is a sizable group of other large cities which do not prohibit such roof coverings definitely by ordinance, but which over a period of time have practically eliminated wood shingles and have little or no fire hazard from this cause. Included in this group are 14 good sized cities with a total population of over 5,000,000, including such cities as Washington, D. C., St. Louis, Cleveland, Cincinnati and Pittsburgh.

It can be said, therefore, that approximately one-quarter of the population of the United States live in cities in which the wooden shingle is either prohibited or no longer a factor of importance as a fire hazard. Of the 93 cities over 100,000 population which include approximately 39,000,000 people, 53 with a population of nearly 28,000,000, or 72% of the total, now prohibit wood shingle roofs by ordinance or have practically eliminated such roofs.

Nine of the states have a large number of cities with ordinances prohibiting wooden shingle roofs. These are Alabama, Florida, Georgia, Indiana, Massachusetts, New Jersey, North Carolina, Tennessee and Virginia. Other states where a considerable proportion of the population live in cities where shingle roofs are prohibited are: Delaware, Illinois, Maryland, New York and Rhode Island.

Looking at the other side of the picture there are 320 cities over 20,000 population in the United States which permit wooden shingles as roofing, at least outside of the fire limit districts. This group of cities includes approximately 26,000,000 people, or about 21% of the population of the country. The larger cities that lie in this group include: Los Angeles, Oakland, Detroit, Minneapolis and St. Paul, Kansas City, Mo., Omaha, Buffalo, Toledo, Dallas, Fort Worth, Houston, Seattle, Portland, Ore., and Milwaukee. The extent of

the fire and conflagration hazard from wooden shingles in this group of cities varies considerably, depending upon a number of factors, such as climate, fuel commonly used, close grouping of buildings, etc. Based on frequency of shingle roofs fires cities that stand out are: Detroit, Minneapolis, St. Paul, Toledo and a number of the cities on the West Coast. Sweeping conflagrations are entirely possible in these cities. Analyzing the shingle roof fire frequency by states it can be said quite definitely that the hazard of the shingle roof is especially noticeable in twelve states as follows: California, Illinois, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Missouri, Ohio, Wisconsin and Washington.

Areas of the country where wooden shingle roofs are still very much in evidence include the West Coast, the Southwest, particularly Texas, certain of the Corn Belt States, such as Iowa and Nebraska, and areas around the Great Lakes. The situation in the State of Texas is interesting. Because of the wide use of natural gas as a fuel sparks on shingle roofs do not show up as a very important cause of fire in most of the larger Texas cities. However, the conflagration hazard is quite severe in a number of them because of the large number of wooden shingles used in this area, and the possibilities for trouble from shingle roof fires in the state appear great. Wooden shingle roofs are still all too commonly used in rural districts and on farms. In the farming states year after year a substantial number of the total farm fires are due to sparks on wooden shingle roofs. The conflagration hazard in these areas is very small because of the generally wide spacing of buildings, but the number of individual farm properties destroyed because of the use of wooden shingle roofs is still far out of proportion.

The above survey indicates that substantial progress is being made towards the elimination of this notorious fire hazard, but that there is still much that needs to be done in many sections of the country before the distressing fire loss and conflagration hazard of the wood shingle is completely eliminated.

Tests of Automatic Bulb Extinguishers.*

By H. W. Lange,
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During several years past many observations have been made of the performance, in fire tests, of automatically operated bulb-type carbon tetrachloride fire extinguishers. The devices used in these tests were made in different forms, but all employed carbon tetrachloride as the extinguishing medium.

The two sketches of Fig. 1 illustrate in a general way the two styles of devices tested. One style is designed for ceiling mounting; the other to be mounted on a wall. While no test sample was exactly like either of the sketches, none of them differed in principle and application.

The accompanying Tables 1 and 2 summarize the results of 105 fire tests, of which 91 were made with extinguishers and 14 without extinguishers.

Table 1 — Summary of Fire Tests in Small Rooms with Automatic Glass Bulb-Type Carbon Tetrachloride Fire Extinguishers.

Type of Fire	Number of Tests	Test Results: Fire Extinguished	Test Results: Not Extinguished
Class A. Fires with Woodwool	15	1	14
Class B. Fires with Cotton Waste	18	4	14
Class B. Fires with Gasoline	58	16	42
	91	21	70

Table 2 — Summary of Fire Tests in Small Rooms without Extinguishers.

Type of Fire	Number of Tests	Test Results: Fire Extinguished	Test Results: Not Extinguished
Class A. Fires with Woodwool	2	0	2
Class B. Fires with Cotton Waste	4	2	2
Class B. Fires with Gasoline	8	8	0
	14	10	4

Descriptions of all of the tests are not given in this report; instead 23 representative fire tests with three classes of test fires are described. The three

*Copies of this paper are available in a separately published pamphlet issued March 5, 1937, by Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago, Ill. The full title is "Report of Fire Tests in Small Closed Rooms with Automatic Bulb-Type Carbon Tetrachloride (Vaporizing Liquid) Fire Extinguishers."

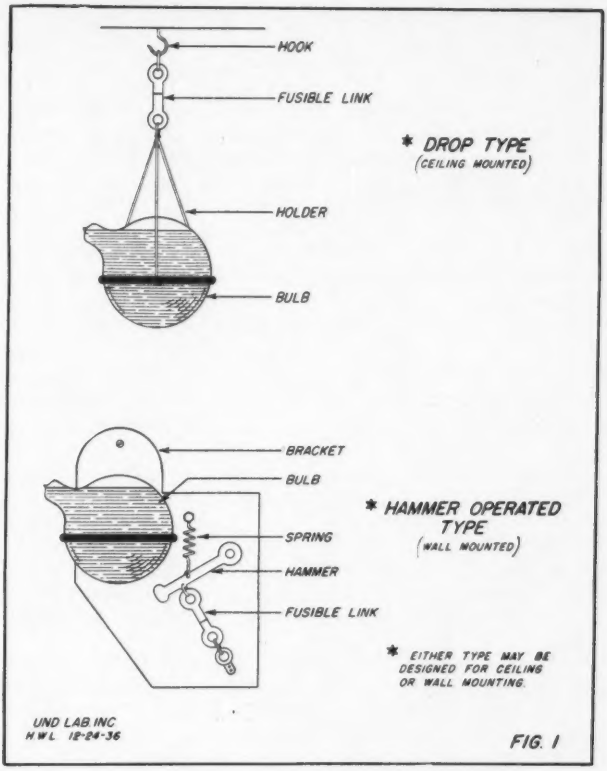


FIG. 1

classes of fire are characterized by the kind of fuel employed as follows:

1. Woodwool excelsior (a Class A fire).
2. Gasoline-saturated cotton waste (a Class B fire).
3. Open containers of gasoline (also a Class B fire).

These types of fires are regularly employed in the classification of various hand fire extinguishers.

In addition, four tests are described, recording performances observed under duplicate test conditions except that no extinguishers were used.

The tests were made in rooms of 1000, 600, or 400-cu. ft. capacity. These rooms were especially built of sheet metal. The 1000-cu. ft. room was 10 ft. x 10 ft. x 10 ft.; the smaller rooms had 9-ft. ceilings. The floors were of sheet steel with sand poured over possible cracks. When completed, the structures were so tight that definite pressure was built up within them following ignition of the burning material.

The ceiling mounted extinguishers were located in the center. The wall mounted devices were placed about 6 ft. above the floor level at the center of one side wall of the test room. Where two wall mounted devices were used for a single test, one was mounted on each opposite wall. When more than two devices were employed, they were spaced evenly about the wall dimensions.

The test fires were located on the floor in the center of the room, unless otherwise noted in the test record. Ignition was by means of a match thrown from the door of the room which was closed immediately. Unless otherwise noted, the door and the windows were tightly closed during each test. The time recordings in the following test record are after ignition occurred.

Test Record.

Woodwool Excelsior Fires.

(1) 1000-cu. ft. room, 1-qt. hammer-operated bulb, ceiling mounted. 2½-lbs. excelsior spread over an area of 30 by 30 in. Extinguisher operated at 17 sec. Test discontinued after 5 min. Fuel practically all consumed but still burning.

(2) 1000-cu. ft. room, two 1-pt. hammer-operated bulbs, wall mounted. 4 lbs. excelsior spread over 4-ft. diameter area on steel support, 1 ft. off floor. Fusible elements operated at 28 and 31 sec. Test discontinued at 3 min., fuel consumed. One extinguisher bulb not broken.

(3) 1000-cu. ft. space, two 1-pt. hammer-operated bulbs, wall mounted. 8 lbs. excelsior spread over 4-ft. diameter area on steel support, 1 ft. off floor. Both extinguishers operated at 36 sec. Test discontinued at 5 min., 30 sec., fuel consumed.

(4) 600-cu. ft. space, 1-pt. hammer-operated bulb, ceiling mounted. 2 lbs. excelsior spread over an area of 2 by 2 ft. Extinguisher operated at 35 sec. Test discontinued at 15 min., fuel consumed.

(5) 400-cu. ft. space, 1-pt. hammer-operated bulb, ceiling mounted. 2 lbs. excelsior spread over an area of 2 by 2 ft. Extinguisher operated at 32 sec. Flames out at 4 min., 5 sec., diminishing glowing continued. Test discontinued at 15 min., fuel 35 per cent consumed.

(6) 400-cu. ft. space, 1-pt. hammer-operated bulb, ceiling mounted. 2 lbs. excelsior spread over an area of 2 by 2 ft. Extinguisher operated 30 sec. Test discontinued at 7 min., 30 sec., when flames were out. Fuel consumed.

(7) 600-cu. ft. space, 1-pt. hammer-operated bulb, ceiling mounted. 4 lbs. excelsior spread over an area of 2 by 2 ft. Extinguisher operated at 30 sec. Test discontinued at 18 min., fuel consumed.

Gasoline-Saturated Cotton Waste Fires.

(8) 1000-cu. ft. space, 1-pt. drop-type bulb, ceiling mounted. 8 lbs. cotton waste spread over an area of 2 by 4 ft. and sprinkled with ½-gal. gasoline. Extinguisher burst in holder at 5 min., 14 sec. Flames not extinguished, test discontinued at 15 min.

(9) 1000-cu. ft. space, 1-pt. drop-type bulb, ceiling mounted. 8 lbs. cotton waste spread over an area of 2 by 4 ft. and sprinkled with ½-gal. gasoline. Extinguisher burst in holder at 3 min., 30 sec., and extinguished the

flames. At 3 min., 49 sec., flames reflashed from glowing embers. Test discontinued at 6 min., fuel burning.

(10) 1000-cu. ft. space, 1-pt. drop-type bulb, ceiling mounted. 8 lbs. cotton waste spread over an area of 2 by 4 ft. and sprinkled with 1 gal. gasoline. Extinguisher burst in holder at 2 min., 28 sec., and extinguished flames. Test discontinued at 17 min. No re-ignition.

(11) 1000-cu. ft. space. **No extinguisher.** 8 lbs. cotton waste spread over an area of 2 by 4 ft. and sprinkled with 1-gal. gasoline. At 1 min., 1 min. 20 sec., and 2 min. the flames were smothered over all except one small corner of the area, and each time the entire area reflashed. Test discontinued at 10 min. Fire not out.

(12) 1000-cu. ft. space, two 1-pt. hammer-operated bulbs, wall mounted. 5¼ lbs. cotton waste spread on 30 by 30-in. pan and sprinkled with ½-gal. gasoline. Extinguishers operated at 40 sec. Test discontinued at 10 min. Fire not out.

(13) 1000-cu. ft. space, 1-qt. hammer-operated bulb, ceiling mounted. 2½ lbs. cotton waste spread on 20 by 20-in. pan and sprinkled with ¾-qt. gasoline. Extinguisher operated at 12 sec. Test discontinued at 5 min., 30 sec. Fire not out.

(14) 600-cu. ft. space, 1-pt. hammer-operated bulb, ceiling mounted. 1 lb. cotton waste spread over an area of 1 by 1 ft. and sprinkled with ½-pt. gasoline. Extinguisher operated at 43 sec. At 6 min., door opened and fire was found still burning. Test discontinued at 15 min. Fire not out.

(15) 400-cu. ft. space, 1-pt. hammer-operated bulb, ceiling mounted. 1 lb. cotton waste spread over an area of 1 by 1 ft. and sprinkled with ½-pt. gasoline. Extinguisher operated at 41 sec. Test discontinued at 10 min. Fire not out.

(16) 600-cu. ft. space, 1-pt. hammer-operated bulb, ceiling mounted. 2 lbs. cotton waste spread over an area of 1 by 2 ft. and sprinkled with 1-pt. gasoline. Extinguisher operated at 18 sec. Fire out at 14 min.

(17) 600-cu. ft. space. **No extinguisher.** 2 lbs. cotton waste spread over an area of 1 by 2 ft. and sprinkled with 1-pt. gasoline. Fire out at 30 min.

Fires in Open Containers of Gasoline.

(18) 1000-cu. ft. space, two 1-pt. hammer-operated bulbs, wall mounted. 1-qt. gasoline floated on water surface in 12-qt. pail approximately 11-in. diameter. Extinguishers operated at 4 min., 18 sec., and 4 min., 34 sec. Test discontinued at 9 min. Fire not out.

(19) 1000-cu. ft. space, two 1-pt. hammer-operated bulbs, wall mounted. 1-qt. gasoline floated on water surface in 12-qt. pail, approximately 11-in. diameter. Placed immediately below and against wall on which one of the extinguishers was installed. Extinguishers operated at 58 sec., and 7 min., 37 sec. Test discontinued at 10 min. Fire not out.

(20) 1000-cu. ft. space, two 1-pt. hammer-operated bulbs, wall mounted. 3-qt. gasoline in 16 by 22-in. pan. Both extinguishers operated at 1 min., 23 sec. One bulb not smashed, but later burst from pressure at 5 min. Fire out at 8 min., 1-qt. fuel unburned.

(21) 1000-cu. ft. space, ten 1-pt. hammer-operated bulbs, wall mounted. One 22 by 26-in. window, 48 in. above the floor was open during the test. 1½-gal. gasoline in 30 by 30-in. pan. Extinguishers operated between 32 and 35 sec. Test discontinued at 6 min. Fire not out.

(22) 1000-cu. ft. space, 1-qt. hammer-operated bulb, ceiling mounted. 2-qt. gasoline in 15 by 15-in. pan. Extinguisher operated at 30 sec. Test discontinued at 5 min. Fire not out.

(23) 1000-cu. ft. space, 1-pt. drop-type bulb, ceiling mounted. 1-gal. gasoline in 20 by 30-in. pan. Extinguisher burst in holder at 2 min., 27 sec. Fire out at 2 min., 30 sec. 3-pt. unburned fuel remained.

(24) 1000-cu. ft. space, **No extinguisher.** 1-gal. gasoline in 20 by 30-in. pan. Fire out at 5 min., 35 sec. 1-pt. unburned fuel remained.

(25) 600-cu. ft. space, 1-pt. hammer-operated bulb, ceiling mounted. 1-qt. gasoline in 1 by 1-ft. pan. Extinguisher operated at 36 sec. Fire out at 5 min. 2/3-pt. unburned fuel remained.

(26) 600-cu. ft. space. **No extinguisher.** 1½-qt. gasoline in 1 by 1-ft. pan. Fire out at 9 min., 30 sec. 1-pt. unburned fuel remained.

(27) 600-cu. ft. space, twelve 1-pt. hammer-operated bulbs, ten wall and two ceiling mounted. One 20 by 24-in. window hinged at the top swung open to allow 3¾-in. opening at the bottom. Bottom sill 48 in. from floor level. 2-qt. gasoline floated on water at level 2 in. from top in 11-in. diameter pail. Ceiling-mounted extinguishers operated at 1 min., 5 sec. Wall-mounted extinguishers operated at 1 min., 32 sec., to 1 min., 50 sec. Test discontinued when fire had consumed all of the fuel at 31 min.

The above-described test performances are representative of the results of the 105 tests listed in the tables.

Summary.

Study of the results of tests with woodwool (a Class A fire) as the fuel shows no practical extinguishing effect under favorable circumstances of placement and lack of ventilation. The test structures employed were tightly constructed, the door and windows closed.

The results of the tests conducted with gasoline-saturated cotton waste (a Class B fire) failed to be convincing as to any extinguishing capacity of the device. Study of tests 10 and 11 and also 16 and 17 indicate that whatever extinguishing effect is afforded by the devices is greatly assisted by the smothering action of the products of combustion.

The tests with fires in open containers of gasoline (also a Class B fire) further demonstrate the influence of the products of combustion. Tests Nos. 20, 23, 24, 25, and 26 (of which 24 and 26 were conducted without extinguishers) show that the operation of one or two devices in a small room has only moderate assisting effect. Tests Nos. 21 and 27 demonstrate that with reasonable ventilation the rooms are not protected by automatic equipment of this type.

Conclusion.

Dumping one or two pints of carbon tetrachloride upon the floors of closed rooms may not be relied upon to control or extinguish fires that are sufficiently intense to cause automatic operation of these bulb-type extinguishers. Ventilation of the rooms reduces extinguishment possibilities.

Small Hose Couplings in Fire Depts.

With the more widespread use of 1½-in. hose for both building and forest fire use there has been growing concern among both fire department members and fire protection engineers in the question of standardization of small hose couplings. The accepted N.F.P.A. standard* for 1½-in. hose is 1.99 in. outside diameter of the male thread, with nine threads to the inch. This is recognized as the most serviceable from the fire department standpoint.

Recently attention has been drawn to the use of garden hose for rural fire fighting work, and the desirability of having provision for connecting booster or chemical hose on fire apparatus to domestic garden hose connections. In outlying areas with limited fire hydrant service or other public water supplies it appears desirable for the fire department to be able to utilize any domestic water supplies available, and for this reason members of fire departments use standard garden hose thread on their apparatus instead of the booster hose thread.

As a result of current interest in both 1½-in. and booster hose couplings a questionnaire was sent by the N.F.P.A. Executive Office to a representative group of large and small fire departments throughout the United States and Canada. As of April 1, 1937, replies had been received from 209 fire departments located in 41 states and 5 Canadian provinces. Seventy-one of the departments reporting were in cities of over 20,000 population. The remainder were in smaller cities and towns or were rural fire departments. A few large industrial fire brigades were also represented. Replies were not complete in all instances, but all except two furnished data that were available for tabulation.

The questions were designed to obtain information on the following points.

1. The size of booster or chemical hose in use.
2. The size couplings on booster and chemical hose.
3. Whether the booster hose couplings will connect to garden hose couplings without an adapter, and whether an adapter is provided.
4. The size couplings on 1½-in. hose.
5. Whether the 1½-in. hose will connect to the tip of the 2½-in. playpipes.

The replies are tabulated to show separately the practice in cities of over 20,000 population and in communities of less than 20,000 people.

Replies to the first question show that most fire departments use ¾-in. booster or chemical hose rather than 1-in. hose, while a few use both sizes. Where both ¾-in. and 1-in. sizes are used with two exceptions the same size

*Standardized by the N.F.P.A. Committee on Hose Couplings and Nozzles.

couplings are used for either size hose. Of the cities of over 20,000 population, 76.1 per cent are either entirely or partially equipped with the ¾-in. size, which is lighter and more easily handled than the larger booster hose. In communities under 20,000 population there is a greater percentage of 1-in. booster hose in use, but 57.1 per cent of the departments reporting are entirely or partially equipped with the ¾-in. hose. The greater friction loss in the ¾-in. booster hose is apparently not considered important due to the small nozzle tips and short lengths of hose generally employed.

The replies to the second question indicate that while a great variety of sizes of hose couplings are in use the majority of fire departments use the chemical engine hose coupling which has an outside diameter on the male thread of 1.375-in. with 8 threads to the inch. Of the large cities 54.7 per cent use this coupling while 67.5 per cent of the smaller departments also use it. There are, however, a number of departments, particularly those using ¾-in. booster hose, which use the garden hose thread. It appears that garden hose thread is entirely suitable for this purpose and its use makes it unnecessary to provide adapters in order to utilize garden hose connections.

The answers to the third question show that garden hose has an important place in fire department work. While but 12.4 per cent of all the departments reported booster and chemical hose couplings which directly fitted garden hose connections, 43.3 per cent of the departments make use of garden hose. In addition to use of garden hose couplings on booster lines, garden hose is utilized by means of adapters, special tips on booster hose nozzles, special pump connections, or by carrying garden hose on the apparatus for use on domestic connections.

The replies to the fourth question show that the N.F.P.A. standard coupling for 1½-in. hose is by far the most popular, being used by 42.1 per cent of the departments which reported the use of 1½-in. hose. The smaller departments had the better record in this respect, as 43.7 per cent use the N.F.P.A. standard coupling as against 38.7 per cent of the larger cities using it. This is probably due to the fact that some of the larger cities selected their coupling sizes before the N.F.P.A. standard was developed. The iron pipe coupling is a poor second to the N.F.P.A. standard coupling in fire department work. The iron pipe coupling is used in only 20.7 per cent of the departments reporting. Some other couplings such as the Pacific Coast standard have some local popularity, but in most of the other departments not using the N.F.P.A. or iron pipe couplings, the 1½-in. hose couplings are of no recognized standard.

It is interesting to note that the use of 1½-in. hose is reported in 69.8 per cent of the fire departments. The proportion of the smaller departments using this size hose is 72.1 per cent, which compares with 64.8 per cent of the larger cities using this size.

The answers to the last question indicate that regardless of the couplings used on 1½-in. hose nearly three-fourths of the departments using 1½-in. hose can connect their 1½-in. hose to the tip of the nozzle on their 2½-in. lines. In most cases this can be done without an adapter. More of the larger cities are equipped to make this connection than is the case in the smaller departments. Where no 1½-in. hose is used by the fire department it is the practice in about half of the departments to connect the booster hose to the nozzle of the 2½-in. hose. A few departments reported other arrangements. A great many special adapters and connections were reported in use by the various departments.

1937 Survey of Small Hose Coupling Practice.

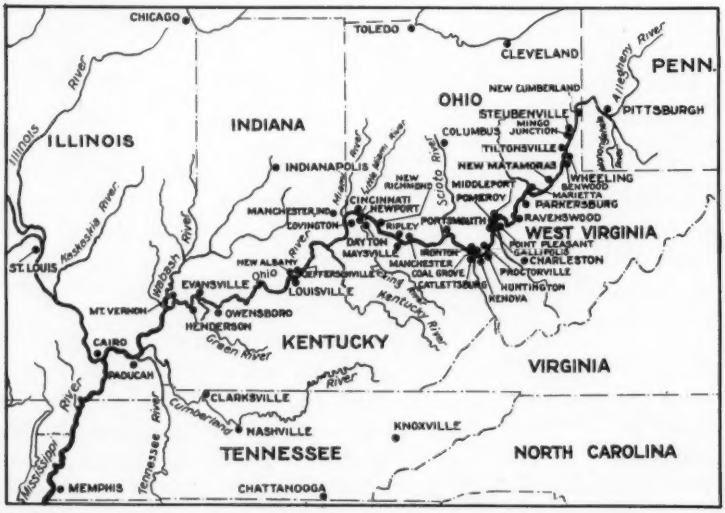
	71 Cities Over 20,000 Pop.		136 Communities Under 20,000 Pop.		Total	
	No.	Per Cent	No.	Per Cent	No.	Per Cent
1. Use ¾-in. hose (Balance use 1 in.—also some use both ¾ in. and 1 in.)	54 out of 71	76.1	76 out of 133	57.1	130 out of 204	63.8
2. Chemical hose couplings (1.375 in.—8 threads per in.)	33 out of 64	54.7	75 out of 111	67.5	110 out of 175	62.9
3. Use garden hose or have garden hose adapter, etc. (1.0625 in.—11½ threads)	33 out of 69	47.9	51 out of 125	41.8	84 out of 194	43.3
4. N.F.P.A. 1½-in. thread (1.99 in.—9 threads per in.)	17	38.7	42	43.7	59	42.1
Iron Pipe 1½-in. thread (1⅞ in.—11½ threads per in.)	9	20.2	20	20.8	29	20.7
**Miscellaneous — 1½-in. thread	18	41.1	34	35.5	52	37.2
Total 1½ in.	44*	100.0	96	100.0	140	100.0
5. Departments having both 2½-in. and 1½-in. hose which can connect 1½-in. to 2½-in. playpipe directly.	34	70.8	63	67.7	97	68.8
With adapter.	4	8.4	2	2.2	6	4.3
Total	38 out of 48	79.2	65 out of 93	69.9	103 out of 141	73.1

*Four departments did not report coupling sizes.
**Almost no two alike.

The Ohio River Flood.

The Ohio River flood, which occurred late in January and early in February, 1937, has been recorded as one of the greatest disasters in the history of the United States. The best estimates indicate that the total property damage resulting from this flood amounted to $500,000,000 and that approximately one million persons were made homeless.

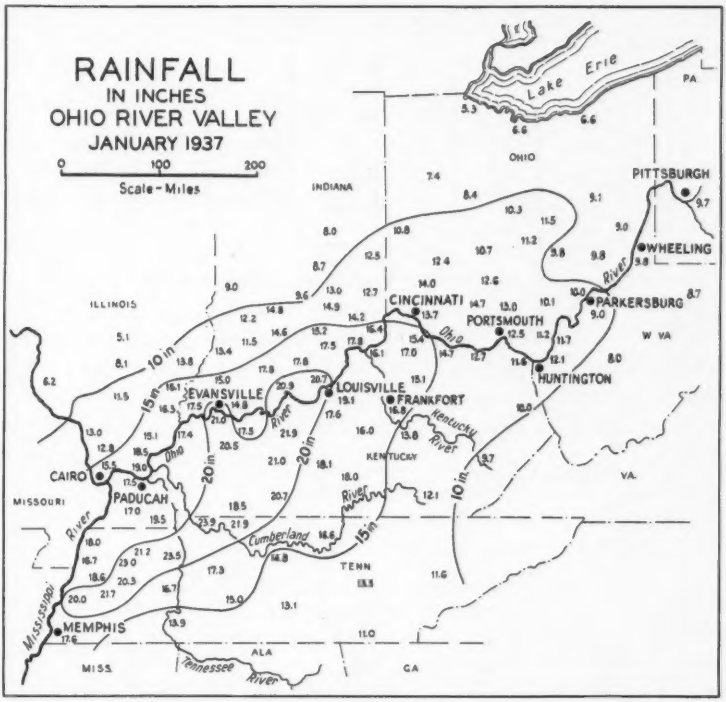
Obviously the matter of fire safety was one of the greatest problems which had to be met in connection with this disaster. Fire protection facilities, including water supplies, were seriously impaired and large areas were isolated by flood waters. Special fire hazards resulting from the emergency included use of unsuitable temporary heating, cooking and lighting appliances; spread of escaping flammable liquids upon flood waters, and fires due to use of damaged electrical equipment.



N.F.P.A.

Map showing the 1283-mile course of the Ohio River, the valley of which suffered its greatest flood during January and February of this year.

This account has been prepared from reports by the Ohio Inspection Bureau (Member N.F.P.A.); Kentucky Actuarial Bureau (Member N.F.P.A.); Indiana Inspection Bureau (Member N.F.P.A.); National Board of Fire Underwriters (Member N.F.P.A.); Associated Factory Mutual Fire Insurance Companies (Member N.F.P.A.); W. J. Fairbairn (Member N.F.P.A.) and data from various other sources.

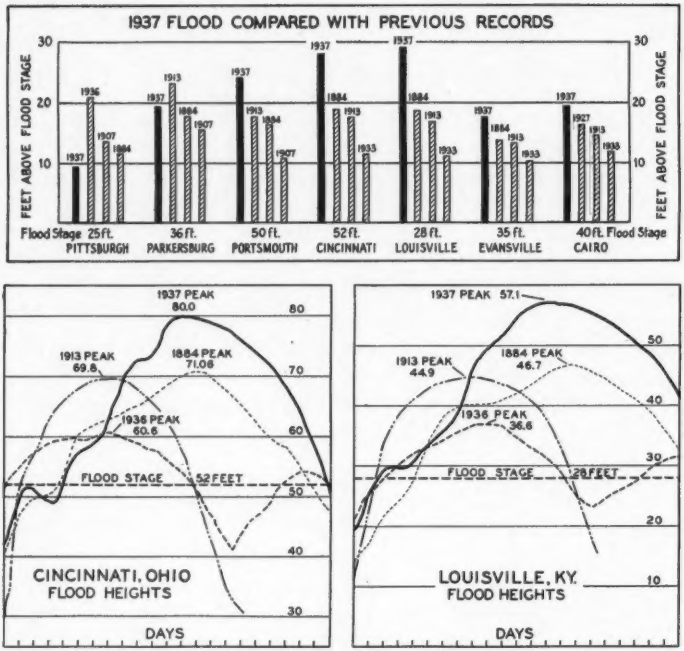


Factory Mutual Record.

This map shows the total rainfall in inches for the month of January, 1937. Most of this flood producing rain fell between the 6th and the 26th.

Weather Conditions Preceding Flood.

Unusually heavy rainstorms along the 1283-mile course of the Ohio River during the month of January, 1937, resulted in a total rainfall of three to four times the normal amount for the month of January. This heavy rainfall was due to warm rain-laden air being sucked up from the south into a low-pressure area extending northeastward over the Ohio River Valley. This low-pressure area was located between a high-pressure area of cold air over the central portion of the United States and another high-pressure area off the Atlantic Coast. The moisture in the warm air condensed upon meeting the cold air masses and heavy rains fell steadily for all but a few days during a period of three weeks. With the ground saturated by previous heavy rains and the Ohio River already above normal, flood conditions resulted which considerably exceeded previously recorded peak levels along the greater part of the river.



Factory Mutual Record.

Flood stage is the level at which the river starts to overflow its banks and cause damage. Flood crests at key cities are shown compared with previous floods.

The following table shows how the level of the 1937 flood compared at various places along the river with previously recorded maximum crests. At the headwaters of the Ohio at Pittsburgh, Pa., it will be noticed that this year's flood came well below the 1936 record breaking height. As the flood descended toward the mouth of the river its level continued to increase due to the large volumes of water added by various tributary streams. The crest at Cincinnati was nine feet above the previous maximum. At Portsmouth, Ohio, the river was twelve feet above the flood wall. At Louisville, Ky., more than sixty per cent of the city was inundated and nearly two-thirds of the population had to leave their homes. At Evansville, Ind., approximately one-half of the city was under water. Near the lower end of the river, Paducah, Ky., was almost completely under water, but Cairo, Ill., at the junction of the Ohio and Mississippi Rivers, was protected by a levee and escaped damage. The levee had been heightened by an emergency wall, but the flood came just below the top of the original levee.

Comparisons with Previous Maximum Flood Levels.

	1937 Increase or Decrease	Date of Previous Maximum
Pittsburgh, Pa.	—11 ft.	1936
Wheeling, W. Va.	—6 ft.	1913
Parkersburg, W. Va.	—3 ft.	1933
Huntington, W. Va.	+4 ft.	1913
Portsmouth, Ohio	+6 ft.	1913
Cincinnati, Ohio	+9 ft.	1884
Louisville, Ky.	+11 ft.	1884
Evansville, Ind.	+5 ft.	1884
Paducah, Ky.	+6 ft.	1913
Cairo, Ill.	+3 ft.	1927

Fortunately at the time of the Ohio River flood, the level of the Mississippi River was below normal so that with extensive flood works and sand bagging, army engineers were able to prevent serious damage along the Mississippi. It is also worthy of note that several cities, including Dayton located along the Miami River, which empties into the Ohio River, suffered no damage because of the automatic operation of a flood control system installed along the Miami River following the disastrous 1913 flood.

Public Water Supplies.

Probably no phase of the flood disaster was more serious, aside from actual loss of life, than the interruption of the public water supplies upon which, in urban areas, both health and fire safety so greatly depend. A number of the cities along the river obtain their water from the river by means of low lift pumps supplying filtering or settling beds from which water is pumped into the distribution systems and reservoirs. Where the pumps at stations near the river level were put out of service the principal remaining supply consisted of water in the reservoirs and settling basins. This condition necessarily resulted in the rationing of water and adoption of other emergency measures. In the larger cities it was possible to maintain restricted service until the system could be returned to normal operation. Some of the smaller communities found their public water supplies entirely depleted before the emergency had passed.

Wheeling, W. Va., was the first large community below Pittsburgh to be affected by the flood, but although one-third of the city was under water the water supply was not impaired and the flood at Wheeling was of comparatively short duration. At Parkersburg, W. Va., however, the pumping station was put out of service for two days when flood waters went over the tops of the deep wells, making it necessary to shut down the electric pumps to prevent contamination. A steam station taking suction from the river was put into service, and the water filtered for a short time until the flood extinguished the boiler fires.

Huntington was the worst affected of the large West Virginia cities. Over seventy per cent of the flat section of the city, including most of the mercan-

Ohio Inspection Bureau.

This small dwelling carried from its foundations by the flood at Marietta, Ohio, is typical of the many unsubstantial buildings which generally suffered the most severe damage.

tile, manufacturing and dwelling sections, was under water to a maximum depth of twenty feet. The main waterworks pumping station had five feet of water on the operating floor and was out of service from 3:40 P.M. on January 26 to 8:50 P.M. on January 29. A barrier was built to protect the pump house, but it was finally decided to allow the building to fill with water to prevent collapse from external pressure. An auxiliary pump house was out of water, but a twenty-four-inch line from that station was broken near the main plant. Drinking water was obtained from private wells. Due to the rupture of two six-inch mains, numerous breaks in private lines and use of extra water for clean-up purposes, the pressure in the business district was not restored until February 5, and some areas were cut off until the following day.

Many of the smaller West Virginia communities were also affected by the flood. Kenova and the adjoining town of Ceredo obtain water from a private water utility with pumping station located in Catlettsburg, Ky. There was twelve feet of water in the boiler room of the pumping plant and five feet of water in the electrical pump room. Electric motors were raised and kept dry. When pumping was stopped on January 24, there were 2,000,000 gallons of water in the reservoir. Water was turned on for thirty minutes each day and 1,000,000 gallons remained when pumping was resumed on February 2. The main business district of Kenova escaped flood damage, but the entire town of Ceredo was under four to twenty feet of water. There were 175 breaks in service lines in the two towns, but no breaks in the supply mains.

At Point Pleasant, W. Va., where flood waters inundated the principal mercantile district to a depth of twenty feet, breaks in service lines caused the water consumption to double. Fortunately the operating room of the water company was three feet above the flood crest and service was uninterrupted.

Ohio Inspection Bureau.

At Ironton, Ohio, this three-story brick-joisted mercantile building constructed with weak lime mortar collapsed as a result of the flood.

At Ravenswood the pumping station was out of service for eight days, and at Buffalo, W. Va., pumping was stopped for two days, but elevated storage supplies were adequate. The town of New Cumberland, W. Va., was able to maintain water service in sections above flood level because water supplies are obtained from springs and wells ten miles from the river.

A number of flood-stricken cities in the State of Ohio also had difficulties in maintaining water service. Details of the conditions at Cincinnati are given in the separate report of the flood disaster at that city by C. M. Stegner, Commissioner of Buildings of Cincinnati, published on page 346 of this QUARTERLY.

At Portsmouth, sixty-three per cent of the city was under water and the flood loss totaled $16,000,000. In addition to heavy damage in mercantile and manufacturing districts, five hundred houses were destroyed by flood waters and 5734 houses were damaged. As in most of the stricken cities the cheaper type of dwellings were the most seriously affected. Five flood prevention pumping stations intended to pump flood waters from the city were flooded and put out of service. On January 21, when water neared the top of the flood wall, the filling of elevated reservoirs began. These reservoirs, with

capacities of 22,000,000; 7,500,000; and 400,000 gallons, respectively, were nearly filled when the pumping station was flooded on January 24.

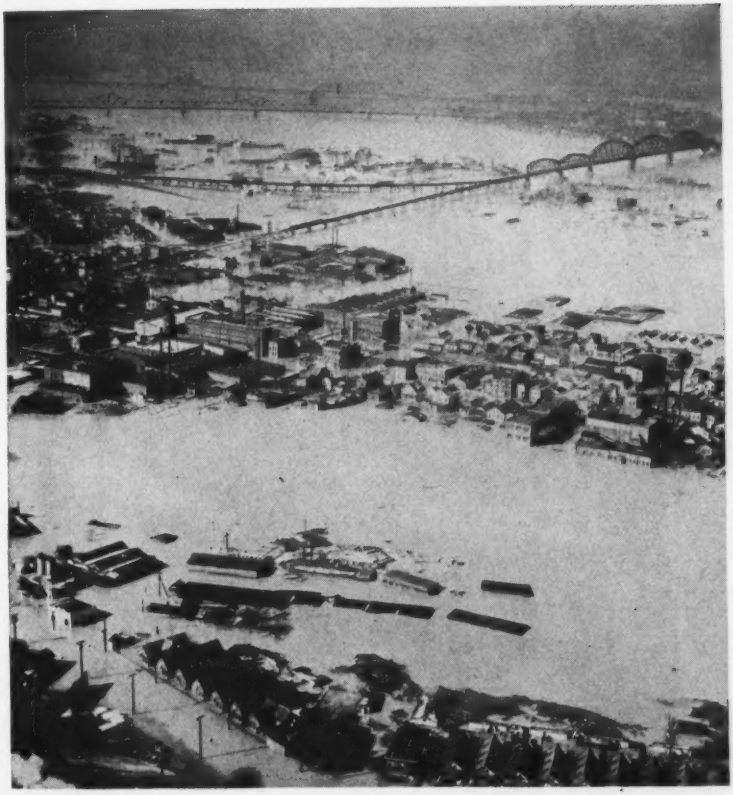
It was at first believed that the reservoir supply would prove adequate, but supplies diminished rapidly, so that rationing began on January 26, with water supplied for three hours a day. Service was restricted later to one hour a day. When pumps were put back in service on February 1, only 2,000,000 gallons remained. Normal daily consumption is 5,000,000 gallons. There were no broken mains, but demands were excessive due to rupture of private service pipes. With one exception all of the electric motors at the pumping station were under water.

At Ironton, Ohio, where the river exceeded flood stage from January 19 until February 3, and reached a peak nearly five feet greater than any previously recorded, seventy-five per cent of the city was covered. There were fifteen to eighteen feet of water in the business district and several old brick mercantile structures having weak lime mortar collapsed. The floor of the pumping station was covered by twenty-six feet of water and the service was suspended from January 25 to January 31. All motors were lifted above the flood, which made it possible to resume pumping as soon as the pumping station pit was pumped out. Large outside transformers at the pumping station were short circuited and destroyed, but new transformers were installed without delay. Ninety per cent of the contents of the 4,000,000-gallon hilltop reservoir was consumed during the interruption to pumping. During the emergency two manufacturing plants pumped a total of 500,000 gallons a day into the city mains.

At Gallipolis the mercantile district and most of the residential sections were flooded, and there were two feet of water on the floor of the pumping station, which was shut down from January 24 to January 31. Electric motors were raised above the flood, but two Diesel electric generators were partly submerged. The reservoir containing 2,000,000 gallons was exhausted on January 28, but domestic needs were taken care of by pumps at a State hospital.

Pomeroy, Ohio, was ninety-five per cent flooded to a maximum depth of twelve feet and the pumping station was put out of service. After the pit at the pumping station was cleared following the flood, 100,000 gallons of water had been placed in the reservoir when several boiler tubes blew out on February 4. It was then discovered that the reserve boiler could not be used due to settling of the building.

The Marietta pumping station was flooded to a depth of four feet on the operating floor and the 4,000,000-gallon reservoir was shut off, with an exception of two hours each day. When pumping was resumed, 2,500,000 gallons remained in the reservoir. Electric motors and one of the two Diesel electric generators were hoisted above the flood level. Fear of overloading the building prevented the raising of the second generator.

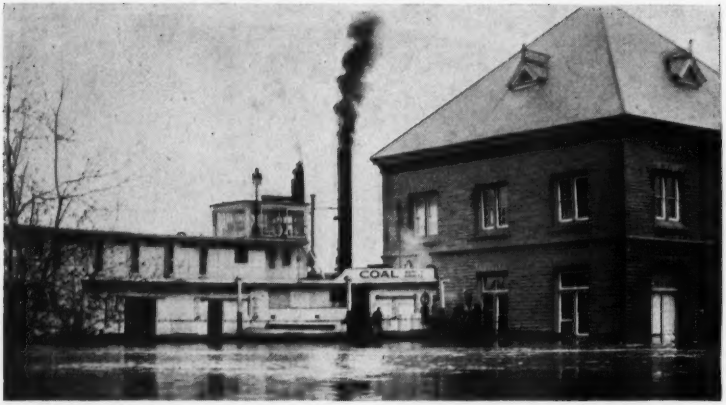


Louisville Courier Journal.

Air view showing a small section of the flooded area of Louisville. The bridges in the background cross the Ohio to Jeffersonville and Clarksville, Indiana.

Smaller Ohio communities in the path of the flood also experienced serious interruptions to their normal water supplies. The Ripley, Ohio, pumping station, which also housed a small reserve steam electric generator, was inundated fourteen feet above the floor. An elevated storage equal to ten days normal supply was exhausted in two and a half days due to broken service connections, and the town was without water from January 23 to February 6, when electric pumping apparatus was partly restored to service.

At New Richmond the pumps were located on a balcony above previous flood levels, but with eighteen feet of water over the station floor the station was out of service from January 24 to February 8. Service could not be restored until electric motors had dried out. The 700,000-gallon storage tank was exhausted in two days due to a hundred leaks and breaks.



Factory Mutual Record.

The river towboat at the left supplied steam to the pumping station at Louisville, keeping one large pump in operation.

More than three-fourths of the area of Manchester, Ohio, was flooded and water stood fifteen to eighteen feet deep in the business district. Not more than a fourth of the frame buildings in the flooded portion escaped damage and two hundred were moved from their foundations. Water reached a level of eight feet above the roof of the concrete building housing the pumping plant, which was put out of service on January 24. One wall fell inward, covering the pump and breaking the distribution main. Due to this break and leaks in service lines the elevated tank was drained in a few hours. Electric service to the plant and transformers was destroyed. The town had no water until February 4, when two small pumps over wells at an ice factory were connected to the system and supplied twenty-five gallons per minute. Two weeks after the flood, service was still shut off in one-half of the town due to broken mains and pipes and was restricted in other sections.

The pumping station in New Matamoras, Ohio, was shut down for nine days when water covered the pumping station floor and flooded the station pit. The 90,000-gallon reservoir was shut down when half empty in order to retain water for fire service. At Proctorville, Ohio, valves and piping in the pump house were frozen and broken, and the elevated tank was drained before service was restored.

In Kentucky the important cities of Louisville and Paducah were seriously affected by the flood. The water supply for the city of Louisville is obtained through a pumping station at the river supplying settling basins and filter beds on a hill above flood level. From these basins other pumps deliver filtered water to the distribution system with excess water overflowing to an elevated reservoir at the far end of the system. The flood at Louisville reached a point twenty-nine feet above flood stage and submerged the boilers at the

Factory Mutual Record.

The pumping station at Evansville, Indiana, never before affected by a flood, was put out of service when water rose eighteen inches over the floor of the boiler and pump rooms.

river pumping station. When the pumps stopped, the basin at the filter plant contained 42,000,000 gallons of water and the reservoir 25,000,000 gallons. These supplies were conserved by shutting the valves. A river towboat was obtained and supplied steam to one of the large triple-expansion pumps at the river pumping station. At first the pump was run with water as the only lubricant for the main bearing which was six inches under water. Later an oil pipe was attached, making it possible to supply oil from the pump balcony. The pump was operated with the flywheel half submerged, which reduced the capacity from 24,000,000 to 15,000,000 gallons a day. About 7,000,000 gallons were filtered each day and the balance was reserved. The south end of the city was supplied from the elevated reservoir one hour each day. Full pressure was restored after thirteen days.

In Paducah the pumping station and filter plant are in the same location near the river. Low lift pumps deliver water to a coagulating basin from which it passes through filters. Other pumps at the same station deliver filtered water to the mains with overflow to a 5,000,000 reservoir. The filters were not flooded, but the water reached nearly five feet above the floor of the station and put the boilers and steam pumps out of service. Water was over the station floor for three weeks and the reservoir was exhausted long before the flood subsided. The pumps were out of service for twenty-four days.

Evansville, Indiana, was another large city which was seriously flooded and had its water supply interrupted. The supply is obtained from the river through a purification plant. The pumping station floor is at an elevation of fifty-three feet and the boiler room fifty-one feet above the zero river stage. There is an eight-foot basement surrounding a concrete pump pit sixty-one feet deep. There are some openings from the basement through the pit wall.

Cincinnati Enquirer.

One of the fire department pumpers at Cincinnati stationed at the edge of the flood with hose lines connected into hydrants on the separate high pressure fire main system, ready to supply water for fire fighting in the business district.

The purification building was above the maximum flood level of 53.77 feet. After the river reached forty-eight feet on January 23, all pumping station employees remained on continuous duty, sealing leaks as they appeared, and the boiler room was bricked up. Leaks developed in the pump room basement wall and on January 26, a leak developed in an inaccessible location around a thirty-inch discharge main. An attempt was made to stop the leak from the outside with sand bags, but the force of the water was sufficient to carry entire sand bags through the leak. When it became evident that efforts to stop the leak had failed, electrical equipment, including pump motors, was raised by crane and placed on blocking on the main floor. When the pumps were shut down the reservoir contained practically the entire capacity of 20,000,000 gallons. The reservoir was turned on for one hour each day, and when the service was restored 14,800,000 gallons remained.

Following the shut-down steps were immediately taken to utilize available private well supplies and by January 31, ten wells were connected to the water system either directly or through hydrants providing 5,000,000 gallons a day. At the pumping station, efforts were promptly started to resume service and a cofferdam was constructed around the point of failure, the leak stopped, and the main floor and boiler room floor freed of water and the boilers started on January 30. A small generator was then put in service. A sand dredge having a pump of over 12,000,000 gallons a day capacity was chartered and delivered raw water to the mixing chamber of the purification plant. On February 1, one high lift pump was put back in service, restoring normal pressures throughout the city. One of the low lift pumps was placed in operation on February 6. During the emergency no mains or hydrants were broken.

Fires and Fire Protection.

Fire protection facilities were taxed during the flood to an unprecedented extent. With water supplies interrupted and many fire stations flooded and apparatus evacuated, fire departments were not only called upon to furnish fire protection, but to perform other services, such as the removal of endangered persons from flooded sections, and pumping of water from flooded basements. One of the most interesting features of the flood disaster was the great concentration of firemen and apparatus which went to the assistance of Louisville and Evansville. Distances traveled to the disaster scene in several instances exceeded five hundred miles. However, many of the small communities were left to struggle alone with little or no fire protection. Fire trucks

International.

In addition to fire prevention and fire fighting duties firemen were very active in flood rescue work. This picture shows Cincinnati firemen removing a sick woman from her home.

were stripped of hose for use in street flushing, or pumpers were commandeered for pumping out buildings, with damaging results to the equipment, regardless of pleas of fire chiefs. It is considered fortunate that there were not more serious fires during the flood. The largest fire which occurred during the emergency was the $2,000,000 Mill Creek fire in Cincinnati, reported on page 348. The second largest fire during the flood occurred in Louisville, on January 26, when the Louisville Varnish Company plant was destroyed with a loss of $265,000.

At Wheeling, W. Va., the first city in the path of the flood, two of the nine fire department stations were closed. One of these was on Wheeling Island and the other in South Wheeling. Only two small dwelling fires, causing a total loss of $200, occurred during the flood and eight small dwelling fires

occurred during the drying out period afterward. The fire department pumper in South Wheeling was used for pumping basements for a week following the flood. In the town of Benwood, W. Va., near Wheeling, the fire truck was moved from the flooded fire station, stripped of all but one hundred feet of hose and used for pumping basements. The hose was used for street flushing and left caked with mud and in poor condition. At Parkersburg, W. Va., apparatus was moved from the flooded central fire station, but no serious fires were reported. During the flood fire alarms were received by telephone.

Five of the eight fire stations at Huntington, W. Va., were inundated from five to fourteen feet. Equipment was moved so as to protect all sections not under water. A 750-gallon pumper was placed on a barge attached to a motor boat. Firemen also had a power boat and rowboats carrying chemical extinguishers. Fire alarms were broadcast by a local radio station. The central fire alarm station was not affected, but forty-five alarm boxes were under water and eighteen other boxes were removed before they were reached by water. No large building losses occurred during the flood, but there were ninety fires reported and four or five dwellings were considerably damaged. One serious fatal fire occurred where gasoline from an overturned tank had accumulated on top of the water and was ignited when a woman in a rescue boat tossed a match overboard after lighting a cigarette. This fire resulted in the death of three persons and serious burns to four others. This fire burned for about an hour and destroyed a filling station and the upper parts of two small dwellings. During the drying out process following the flood a large number of small fires occurred due principally to unsafe arrangement of temporary heating devices.

At Point Pleasant the fire station was under seventeen feet of water. One piece of fire apparatus used for rehabilitation purposes was damaged. All of the hose from one truck and part of another was used for street washing and was left frozen in the street. The fire chief took a small pumper with the remaining hose to his home two miles from the business district. After the emergency it was necessary to buy a new pumper and new hose. Two small fires were extinguished with chemicals during the flood and a fire caused a small loss in a restaurant during the drying out process. At St. Mary's, W. Va., a pumper and eight men were placed on a barge to protect flooded sections. Ceredo fire station was flooded to a depth of four feet, but the apparatus was not moved. Following the flood a dwelling in Paterson was destroyed by fire while being dried out.

In addition to Cincinnati other flooded cities and towns in the State of Ohio had difficulty in maintaining fire protection. At Ironton the fire station was inundated almost to the second floor and equipment was moved to higher ground. One of the four fire alarm circuits was completely out and other circuits were largely out of service. One large fire, which destroyed a wholesale

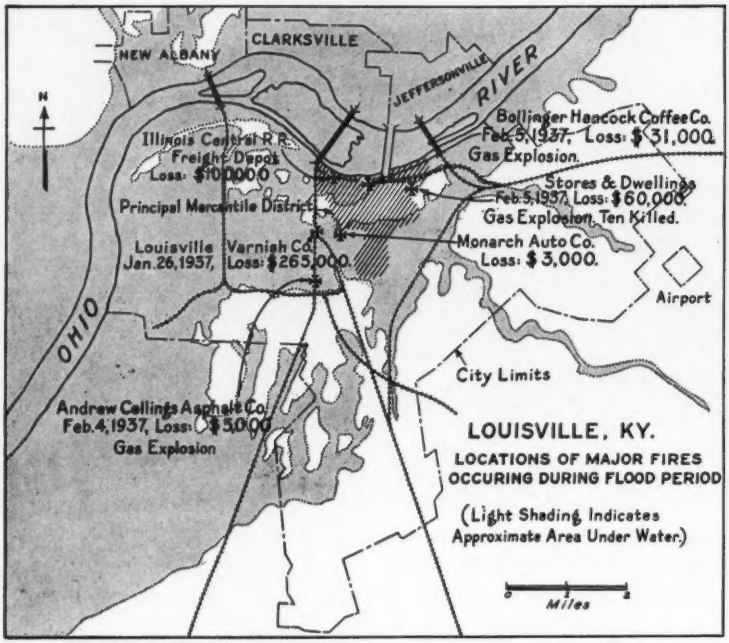
W. A. Rodspinner.

Oil and gasoline from overturned tanks shown on flood waters at Huntington, W. Va., where three lives were lost when a woman refugee in a rescue boat threw a lighted match on the water after lighting a cigarette.

hardware plant, was caused by thieves stealing ammunition. The property was surrounded by twelve feet of water when the fire occurred and chemical extinguishers were used from boats to protected adjacent property. Following the flood Ironton had several small fires due to defective or damaged flues. There were also numerous automobile fires due to draining off gasoline for use in stoves.

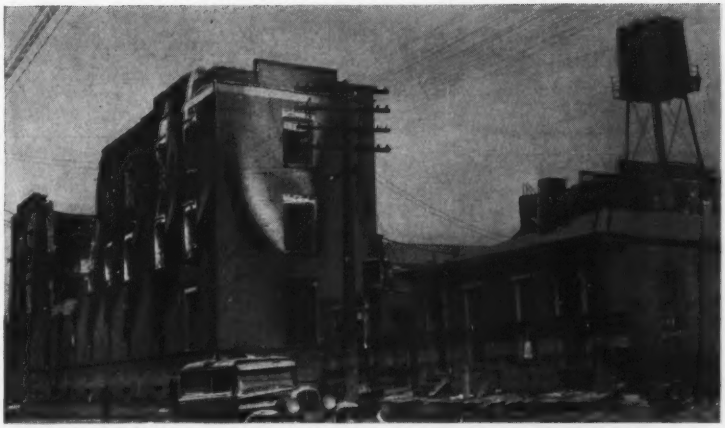
At Portsmouth three of the four fire stations were flooded, as was the New Boston fire station which operates with the Portsmouth fire department. Apparatus was removed from flooded sections with the exception of one pumper, which was left on the second floor of a downtown garage for use on a barge if necessary. A patrol maintained by the Coast Guard in power boats equipped with chemical extinguishers extinguished two small fires. These and a fire outside of the flood area were due to defective heating arrangements. During rehabilitation a number of fires occurred due to electrical short circuits, gas leaks, temporary heating appliances and the use of gasoline for cleaning walls. With the exception of a $2500 restaurant fire all losses were small. The fire alarm system was out of service until February 11, but a special telephone line was available for fire calls. Fire alarm boxes were moved before reached by flood water and were promptly replaced following the flood.

At Manchester, Ohio, the fire truck was moved from the station, which was under twenty feet of water. Several small fires due to defective heating devices and short circuits of wiring were extinguished with chemicals. The fire alarm siren could not be operated because control wires from the telephone exchange were broken.



The New Richmond fire department equipment consisted of two hand hose reels, which were moved from the flooded station, but were of little value, as most of the town was under water. After the water receded, a fire due to use of open grate fires for drying purposes destroyed a dwelling. Due to the extensive flood damage which drove them from their homes, most of the volunteer firemen had not returned to the town when the alarm sounded.

In several towns fire department pumpers were diverted from their regular purpose to aid in clean-up work. The Brilliant, Ohio, pumper was engaged for four days in pumping out cellars, but was used to extinguish a $1000 fire. The only pumper at Coal Grove was sent to a manufacturing plant to do clean-up work. At the town of Pomeroy, Ohio, the only piece of fire apparatus was used for pumping cellars. All good hose was removed from the truck and left at the station. Old utility hose was thrown on the truck which was not ready for alarms. The Middleport pumper was kept loaded ready for fire alarms, although it was used for street flushing and pumping out basements. The Mingo Junction fire department, after using their pumper for pumping out basements, one afternoon purchased a small gasoline pump to relieve the fire apparatus of this work. The Tiltonsville pumper used to pump out cellars in that town and Rayland was somewhat damaged by cinders, which reduced



Factory Mutual Record.

Ruins of the Louisville Varnish Company plant which burned while completely inaccessible due to flood water, the height of which is shown by the oil scum line on the buildings. With the public water supply shut off, the sprinkler tank was quickly drained due to a flash fire from naphtha which escaped from storage tanks at the plant.

the possible suction lift of the machine twenty-five per cent. Few calls were received to pump out basements after a fee of five dollars was established for this service.

Louisville Fires and Protection.

One of the largest fires which occurred in conjunction with the flood destroyed the sprinklered brick-joisted plant of the Louisville Varnish Company on January 26. The fire occurred at 3:05 A.M., when the plant was surrounded by flood waters and was inaccessible to the fire department. The fire apparently resulted when naphtha tanks in a covered concrete pit were lifted by the flood waters, breaking connections and releasing the naphtha. The buildings and a brick wall formed a yard enclosure which confined the floating naphtha. The boiler fires ignited the vapors and fire flashed over the naphtha, opening many sprinklers in the plant buildings. The public water supply was out of service and the 20,000-gallon sprinkler tank was quickly drained. Other flammable liquids ignited, adding to the fire, and the plant burned to the water line with a loss of $265,000.

The greatest loss of life by fire during the emergency period also occurred in Louisville. Ten persons lost their lives in a gas explosion which wrecked a three-story store and dwelling block on February 5, and caused property damage of $60,000. This disaster was due to the carelessness of a coal truck driver who dumped a load of coal in the basement and broke a gas main. The driver claimed that the escaping gas sounded like water running in the basement

Acme.

Ten persons lost their lives and $60,000 damage resulted from a gas explosion at Louisville, Ky., on February 5. A truck load of coal dumped into the basement broke gas piping. The truck driver believed the sound of escaping gas to be flood water in the basement, and did nothing about it. The explosion occurred when a man went to the basement to investigate.

and he thought that the noise was due to flood water remaining in the basement. Later the gas was ignited by someone going into the basement. Other large fires in Louisville destroyed an Illinois Central Railroad freight depot with a loss of $100,000, and the Bollinger-Hancock Coffee Company building with a loss of $31,000.

The Louisville Fire Department, consisting of twenty-three engine companies and eight ladder companies and 315 men, was greatly augmented by outside assistance which was assembled under the direction of City Manager Paul Morton of Trenton, N. J., a former Louisville resident, who came by airplane to direct this work. Firemen with pumpers and other apparatus responded from more than twenty cities, including Chicago, Ill., Pittsburgh, Harrisburg, and Philadelphia, Pa., Charlotte, N. C.; and Augusta, Ga. This outside assistance was of great value in relieving the overtaxed local firemen and assisted at many fires. Following the emergency it was stated that many of the Louisville pumpers were in very poor condition from pumping out basements, even though a part of this work was done by obsolete steam fire engines brought out of retirement.

At Paducah, Ky., there were several extensive fires, including a group fire which started in a feed and coal company plant in the North Side business district on February 2, and spread to a grain elevator, hosiery mills, stables and other property. Fire equipment mounted on a barge proved inadequate

Evansville Press.

An improvised fire boat stationed at an inundated fire station at Evansville, Ind. Five such boats were in service in Evansville during the flood. The largest was equipped with a 600-gallon pump and 600 feet of 2½-inch hose. The other pumps were of 200 gallons a minute capacity.

and a $75,000 loss resulted. Another fire in Paducah destroyed three flood isolated dwellings, which had been vacated by their owners. The fire department responded in a coast guard boat and reported that the fire originated from an overheated stove in the attic of one of the houses. The stove was supposedly installed by some person taking refuge in the attic.

At Evansville, Ind., the 157 members of the fire department were on continuous duty for two and a half weeks during the emergency. At all times one platoon was assigned to fire duty and the other to rescue and special work. The fire department consists of eleven engine, two hose, and four ladder companies located in thirteen stations. One station was submerged and several companies were relocated to provide better response to isolated sections. A call for outside aid was answered by fire departments of eight other Indiana cities, who responded with a total of seven pumpers and seventy-five men.

As the water rose at Evansville four small boats were purchased and a large one borrowed for fire service. All were equipped with outboard motors. The large boat had a 600-gallon pump, 2½-inch and 1-inch hose, and ladders. This was placed in service at the flooded fire station. The smaller boats were equipped with 200-gallon pumps. After the water supply failed, a survey was made of sewer manholes to determine the availability of water for pumper suction. It is stated that no part of the city was more than four blocks from such a supply.

The flood stage at Evansville is thirty-five feet. This was reached on January 11, and the level was above forty-eight feet for seventeen days be-

Pictures, Inc.

Three flood isolated dwellings were destroyed by fire started by a stove used by refugees in the attic of one of the houses. Prevalence of fire retardant roofing in the vicinity was an important factor in limiting the fire to three closely built houses.

ginning January 24. During this period there were seventy-three alarms of fire, of which forty-one were from buildings more or less surrounded by water. Six fires required the use of large hose streams and the large boat was used at two fires. The losses were below normal during the flood period. Three fires with losses of $500 each were the largest reported. At Manchester, Indiana, a fire destroyed a general store and oil station. As telephone service was suspended it was necessary to drive to the next town to obtain aid while a bucket brigade fought the fire.

At Evansville thirty-five fire alarm boxes were removed from a circuit in the flooded section. Grounds on another circuit put nineteen boxes in the congested value district out of service. With the exception of one box on another circuit which was overlooked and submerged, the rest of the alarm system was kept in operation.

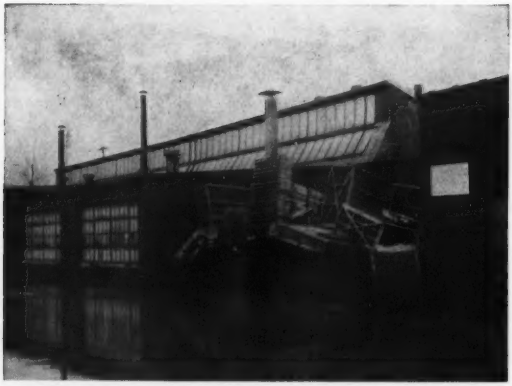
Telephone service was also maintained except in heavily flooded areas. A fire department pumper was used for several days to keep cable manholes in front of the telephone central station dry.

Fire Prevention Activities.

With the serious impairment of fire protection facilities there is little doubt that the reason why more serious fires did not occur was the energetic inspection and fire prevention work done by fire protection engineers of various insurance organizations, together with firemen, city building officials, and utility company employees. During the flood one of the important tasks was the supervision of the crowded public refugee centers established in numerous churches and other available halls. Temporary heating appliances presented a very considerable fire hazard. Use of kerosene and gasoline lamps and stoves by persons unfamiliar with their use presented serious danger. Flammable liquid storage formed another hazard where the buoyancy of water might cause escape of the flammable contents.

After the water subsided the hazards which gave the most difficulty were the use of salamanders and other sub-standard arrangements for drying out flood damaged buildings, the danger of flood damaged electrical equipment and wiring, and escaping gas through broken service connections as well as possible water in the gas pipes. A hazard in rural areas was the spontaneous ignition of hay which had become wet by the flood.

In addition to fire prevention inspections insurance engineers were active in checking sprinklered properties to shut off sprinklers where heat could not be maintained and to have protection restored as soon as possible. Special watchmen were obtained where possible for plants where protection was impaired. Where single source sprinkler systems depended on interrupted public water supplies the system obviously furnished no protection in the emergency. Where secondary supplies in the form of tanks were available, there were some instances where these supplies were tapped to provide emergency public



Factory Mutual Record.

These empty fuel tanks were lifted by flood waters, raising and wrecking a heavy concrete slab, which was originally eighteen inches below the water level shown in the picture.

water supplies. Several ingenious methods were devised for maintaining pressure in dry pipe sprinkler systems where the air pump was out of service. These included use of a portable air compressor mounted on a boat, and use of cylinders containing carbon dioxide or other compressed gases.

At Huntington, W. Va., inspection bureau engineers checked the congested area for fire hazards both during and after the flood. The City Electrical Department made recommendations to the electric power company for safety measures before service was restored to buildings which had been flooded. At Wheeling electrical wiring was inspected by the inspection bureau's electrical inspectors and building and fire department employees. In the Ohio cities and towns the Ohio Inspection Bureau men made inspections of heating appliances and electrical equipment. At Ironton, Ohio, the city manager had lists prepared of flood damaged buildings which had been condemned, and of buildings which required repairs before occupancy.

At Louisville, the Kentucky Actuarial Bureau and the Fire Prevention Bureau of the Fire Department carried on a vigorous fire prevention program. The Fire Prevention Bureau made inspections throughout the city. The city electrical inspector enlisted the aid of all former electrical inspectors and a number of competent electricians from the local electrical organization. Inspection of electrical equipment was made a W. P. A. project, with twenty-five men under the direction of the city electrical inspector. The entire submerged area was inspected and temporary electrical connections were given with the understanding that within ninety days the equipment would be overhauled and brought into conformity with the Code requirements. Large warnings were printed in the newspapers, advising people of the dangers of flooded elec-

trical wiring, and similar warnings were broadcast over the radio on three consecutive evenings by the Kentucky Actuarial Bureau. No fires have been reported caused by wet wiring or other flooded electrical equipment.

At Evansville, Ind., the wires were cut at the electric service entrance of all buildings where wiring was submerged. As the water receded, buildings were inspected and where damage was suspected a temporary notice prohibiting occupancy was posted. These were followed up by detailed inspections for structural stability and condition of chimneys and heating appliances. A number of buildings were held vacant for ninety days to await developments. Before electricity was reconnected a preliminary inspection was made by the city electrical department. Repairs or replacements were required to be made by a licensed contractor who reported to the electrical department before power could be turned on.

Early in the flood orders were broadcast for persons in charge of storages in excess of one hundred gallons of gasoline to report to fire department headquarters. These were listed and as the flood approached tank openings were tightly closed and each tank was pumped full of water to weight it down. Only three instances were reported where small amounts of gasoline were floating on the water. At one bulk storage yard above ground tanks started to float from the foundations. Flood water was kept pumped out, first by a fire department pumper and later by a private pump, and the tanks settled back without damage. Two underground fuel oil tanks floated out during the flood, damaging an adjacent building.

At the forefront of the fire prevention efforts in Indiana were members of the State Fire Prevention Association who were deputized by the Fire Marshal's office. The members were sent to the refugee centers, where persons were crowded into rooms with questionable exit facilities, and looked after fire safety by establishing a twenty-four hour fire patrol. They ordered the removal of rubbish and other hazards; controlled smoking by refugees; and supervised temporary heating devices.

Damage to Public Utility Services.

In addition to the public water systems other essential public services, including gas, electricity and telephone, were seriously affected in most sections of the flood area. In some cases communities outside of the flooded sections were deprived of electrical services by the failure of power stations in flooded sections. Franklin and Middletown in Ohio, which receive power from Cincinnati, were without electrical service although outside of the flooded area. Gas service in many communities was more completely interrupted than the electrical service. Gas service was suspended at Point Pleasant, Henderson and Huntington, West Virginia and in Ironton, Portsmouth, Middletown and Proctorville, Ohio. In most of the other flooded communities gas service was

Acme.

Tank cars, shown floating upon the flood waters near the Louisville and Nashville Railroad building at Louisville, added to the flood fire hazards. The Louisville freight depot of the Illinois Central Railroad was destroyed by a fire during the flood.

off in flooded sections and adjacent areas. Electrical service was badly affected in flooded sections, but in most cities was maintained outside of the flooded districts. Ravenswood, W. Va., was without electric service for five days until a new bank of transformers could be obtained to replace those damaged by the flood. At New Cumberland, W. Va., electric service was continued in flooded sections with the meters removed and jumpers installed. Telephone service was maintained where possible, but was suspended in badly flooded areas. In some of the smaller communities telephone service was completely suspended. Considerable damage was done to underground cables by water entering conduits and manholes.

Lessons and Future Plans.

As a result of the experience gained from this record breaking flood a number of the cities which were affected are planning improvements to prevent a repetition of the worst features of this disaster. At Cincinnati a complete disaster or emergency plan has been prepared as described elsewhere in this QUARTERLY. At Portsmouth, Ohio, the fire chief is on a committee of the Ohio Fire Chiefs Club which is preparing a state wide emergency plan. Improvements contemplated at Portsmouth include removing the waterworks station to a location which will require a level twenty-five feet above the 1937 crest before flooding. In addition a sixth flood prevention station is to be erected and all of the stations will have automatic electric pumps with the

present steam pumps in reserve. A portion of the earth levee is to be replaced by a masonry flood wall. The electrical ordinance is being revised to minimize damage by future floods and will require inspections following both new and repair work.

At Manchester, Ohio, plans are being made for either a new waterworks station at a safe level or the elevation of the present station. Huntington, W. Va., has prepared no general plans for meeting future floods, but is making arrangements to protect the pumping station. The town of New Cumberland, W. Va., is installing a remote control switch for the fire siren, which was inaccessible during the flood.

Among the outstanding lessons of this flood is the fact that safety can not be based on previous experience alone. Weather Bureau records show that a flood of the same magnitude may come at any time during the months from December to April. During the present flood the crests were very accurately predicted a week or more in advance. Unfortunately lack of knowledge or refusal to believe that the great heights predicted could be reached was partly responsible for the great damage. In areas subject to floods, markers showing various flood levels would be extremely valuable in connection with warnings as to the levels expected from approaching floods.

Flood defense for specific localities such as cities can be obtained by building flood walls and levees. However, any extensive encroachments on the waterway will result in higher flood crests unless correlated with flood restraining or impounding works on the tributary rivers. The Ohio would be able to take care of its own flow if floods along tributary streams were controlled as has been done along the Miami River.

The greatest lesson of the flood from a fire protection standpoint is the importance of locating the waterworks plant so as to insure a certain supply. Settling basins, filters, and pressure pumps delivering clear water to the distributing system and reservoirs should be above the flood level. For low level waterworks buildings, such as low lift pumping stations taking supplies from the river, walls and dikes should be installed. Buildings should be made as watertight as possible and sump pumps provided to keep out water. Reservoir supplies should be ample to provide for long emergency periods. Electric power stations should also be located above flood levels where possible. Transformers and switches can be placed at safe elevations.

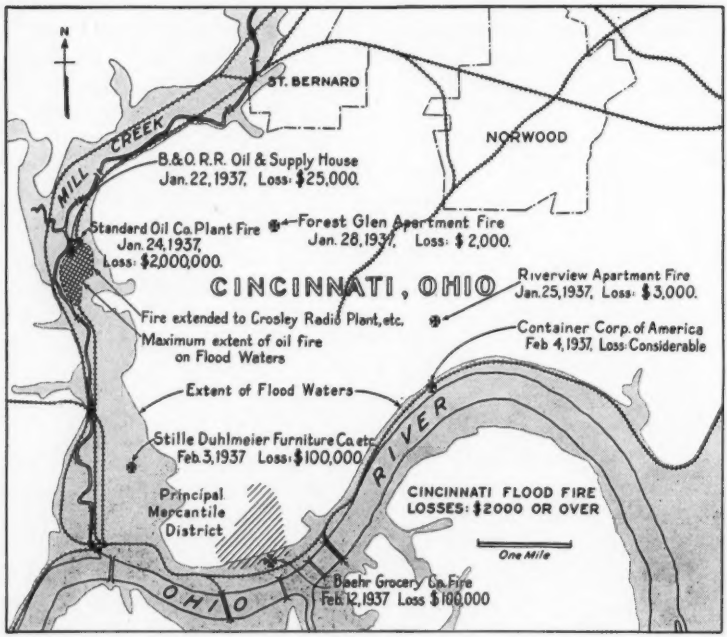
A well-considered emergency plan, of value in any community, is especially important where flood conditions may be expected. Special pumping equipment or siphons are needed in order that the regular fire department apparatus may be reserved for fire duty. During floods when water supplies, fire alarm and telephone services are suspended is not a time to detail fire apparatus to other work and risk serious damage to fire fighting equipment.

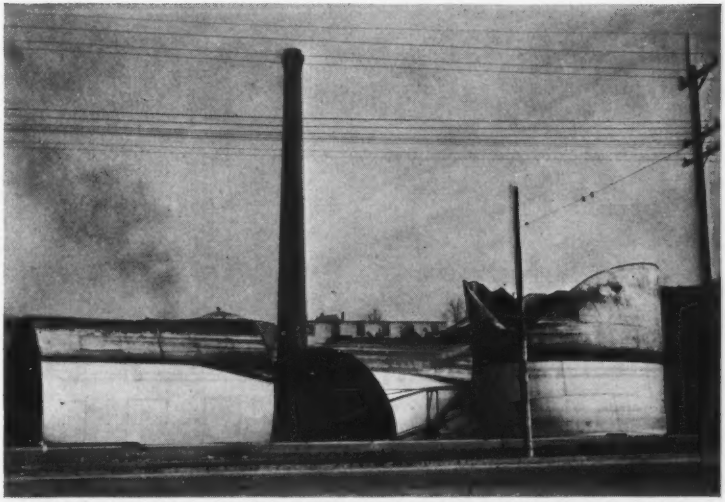
The Flood and Fires at Cincinnati.

By C. M. Stegner, Commissioner of Buildings,
(Member N.F.P.A.)

During the past 67 years the Ohio River has 43 times exceeded the Cincinnati flood stage of 52 feet. The 1884 crest of 71.1 feet was the maximum until this year's record of 80 feet. Because of the frequency of 60-foot flood stages at Cincinnati, the types of buildings and occupancies of the inundated areas are such as incur a minimum of damage. The so-called "bottoms" of the city contain low cost business and industrial structures with masonry walls. Many of these buildings have tenements in the upper stories. This year's flood, however, reached areas that had never known a flood before and were therefore more vulnerable.

After reaching a flood stage of 61 feet on January 21, 1937, the Ohio River rose over ten feet in two days to exceed its former record of 71.1 feet. The excessive rains continued until a final crest of 80 feet was reached on January 25. The submerged area covered 12.5 square miles out of the city's





Wrecked gasoline and oil tanks and broken piping at the Standard Oil Company plant in the Mill Creek section of Cincinnati, from which flammable liquids escaped over the surface of the flood water, causing a $2,000,000 conflagration when ignited by a spark from a fallen power line. The high water mark may be clearly seen by the washed portions of the tanks.

72 square miles, or 17 per cent. In this area were 7000 residence buildings housing 50,000 people and 2300 business and industrial buildings.

Oil Storage in the Flood Area.

Among the industrial buildings were thirteen bulk storage plants with an aboveground capacity of 8,600,000 gallons of gasoline and oil. There were also about 200 retail establishments with underground tank storage capacity estimated at 750,000 gallons. There was also a considerable quantity of flammable liquid storage for industrial purposes. As the flood rose, warnings were broadcast by the fire and building department employees to fill flammable liquid tanks with water to prevent their movement or collapse. The rise was so rapid and unexpected, however, that lack of time and equipment left many tanks subject to damage that released their contents. At a stage of 70 feet, alarming quantities of gasoline and oil were spread over the flood waters in numerous localities. News items were published, urging extreme care against possibilities of a spark or an open flame in such places.

One of these was in the neighborhood of a Standard Oil Company's bulk distributing station located at the northeast corner of Arlington and Spring Grove Avenues. The Standard Oil Co. structures included a one-story brick garage, a three-story brick and reinforced concrete warehouse filled with oils and naphthas in drums, a storage yard with ten 50,000-gal. gasoline tanks

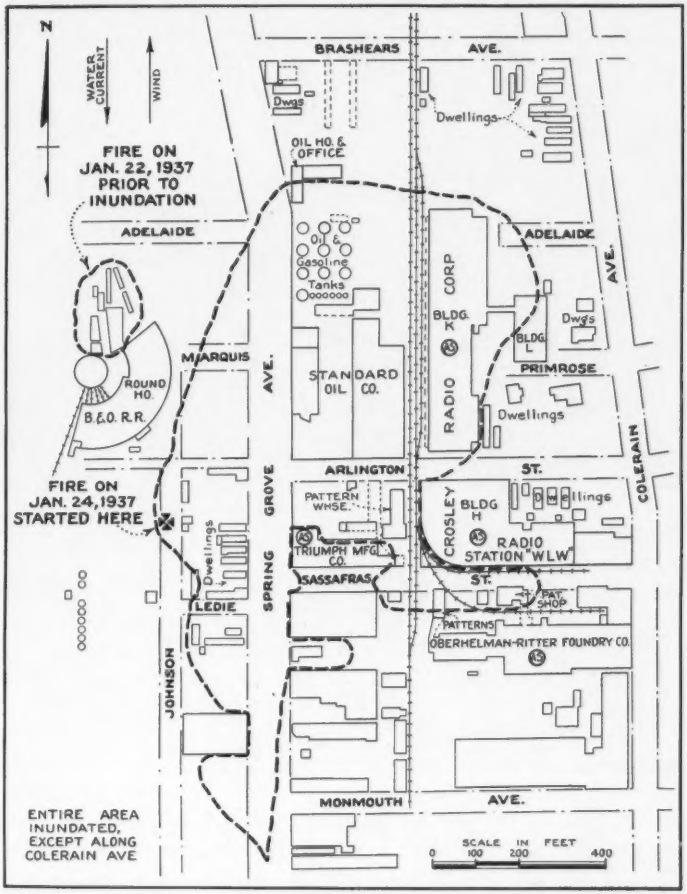
International.

View from the main Crosley Radio building which houses radio station "WLW," showing firemen playing water on the remains of Crosley Building K, occupied for refrigerator assembly. In the background flames may be seen in the fire-resistive Standard Oil warehouse.

and six 20,000-gal. oil tanks. West of the Standard Oil property was a double track railroad siding with sixteen freight cars. West of the siding was a one-story sprinklered brick warehouse of the Crosley Radio Corporation, 150 x 600 feet, filled with combustible merchandise. Southeast of the Standard Oil warehouse was the eight-story sprinklered reinforced concrete manufacturing and broadcasting building of the Crosley Co.

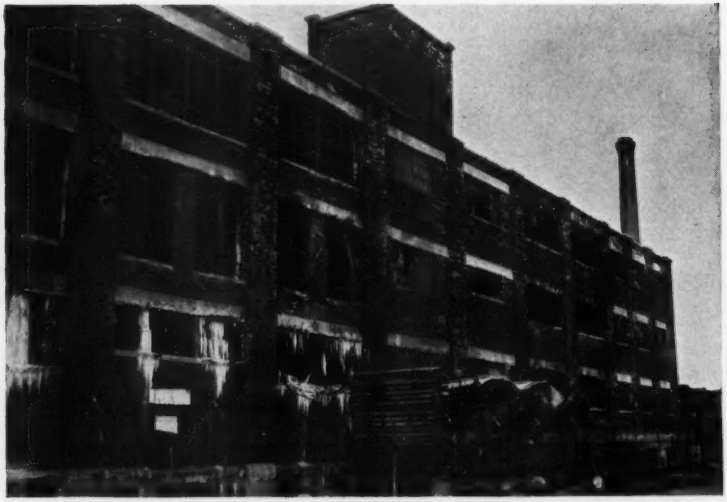
The Gasoline Fire.

At 10:30 A.M., Sunday, January 24, an employee of the Crosley Corporation was reported to have seen a flash on the surface of the flood water west of Spring Grove Avenue. It is believed that this resulted from a short circuit in a broken power line falling against some object and into the water which was covered with gasoline that had been evaporating for several days. The flames spread like wildfire and soon enveloped some frame residence buildings on the west side of Spring Grove Avenue. It was not long before the gasoline storage tanks of the Standard Oil Co. on the east side of Spring Grove Avenue were reached and these soon exploded in rapid succession. The flames on the west side of the eight-story reinforced concrete building of the Crosley Company leaped to a height sufficient to break most of the wired glass in the metal sash on this side of the structure. The Crosley radio announcer began broadcasting a vivid account of the conflagration.



A dozen simultaneous alarms were sent to the fire department and the chief responded with six companies. His first order was for a general alarm, which provided a total of 20 companies and 250 firemen. The fire scene through the rain was appalling, with blazing buildings surrounded by the rising flood waters, which made ordinary means of fire fighting futile. This and the knowledge of similar possibilities around many of the other flooded bulk storage plants with their millions of gallons of gasoline and oil was a never-to-be-forgotten experience.

After four hours of hard fighting, the fire was controlled, with the exception of the blaze in the large concrete warehouse of the Standard Oil Co.

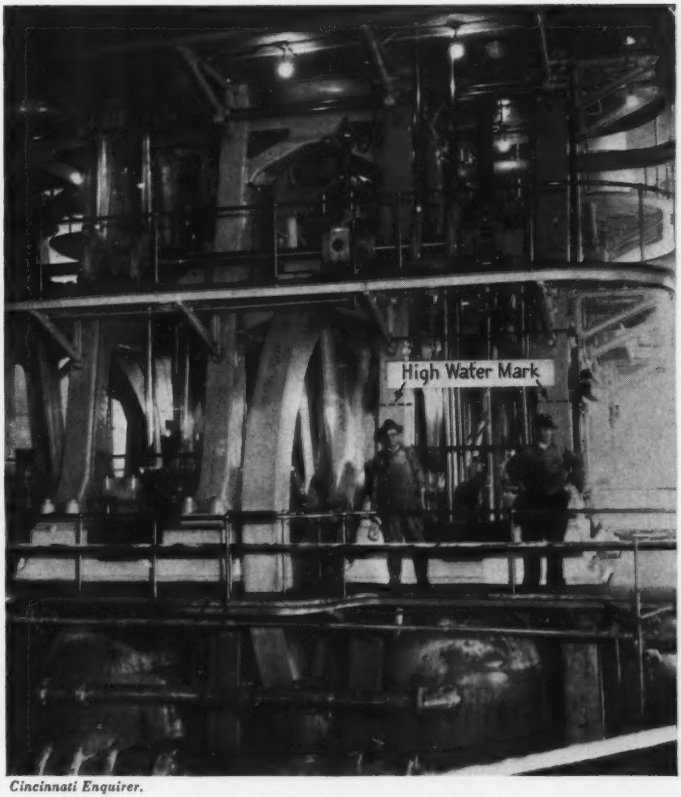


The three-story fire-resistive warehouse at Cincinnati of the Standard Oil Company was practically destroyed by the fire which started from ignition of escaped flammable liquids on flood waters on Sunday morning, January 24, 1937. The fire in this building continued to burn for over twenty-one hours. The wrecked railroad car shown is on a siding between the Standard Oil Company and Crosley Radio Corporation plants.

This fire burned until 8:00 P.M. the next day and resulted in a nearly total loss of the oil company warehouse. The extreme temperature variations between the submerged first floor of the three-story reinforced concrete warehouse and the floors above that were heated by the intense fire, produced temperature stresses that sheared heavily reinforced concrete columns. The one-story sprinklered Crosley warehouse was a total loss for building and contents. The severe exposure fire was too much for the sprinkler system. In addition to the Standard Oil and Crosley buildings, there were a dozen smaller ones wholly or partly destroyed in this conflagration. The estimated loss was approximately $2,000,000. It was fortunate that the fire occurred while the flood was rising, which kept the gasoline and oil in a smaller area than if the flood had been receding with water and gasoline running out.

Damage to the Water System.

The unprecedented height of the flood waters on Sunday, January 24, caused additional catastrophies. The main pumping station of the municipal water works, which supplied Ohio River water to the filter beds, was put out of service when the flood reached a stage of 73 feet at 1:30 A.M. on January 24. The second pumping station that raised the filtered water to the city reservoirs was submerged at 5:30 P.M. on the same day at a stage of 75.5 feet.

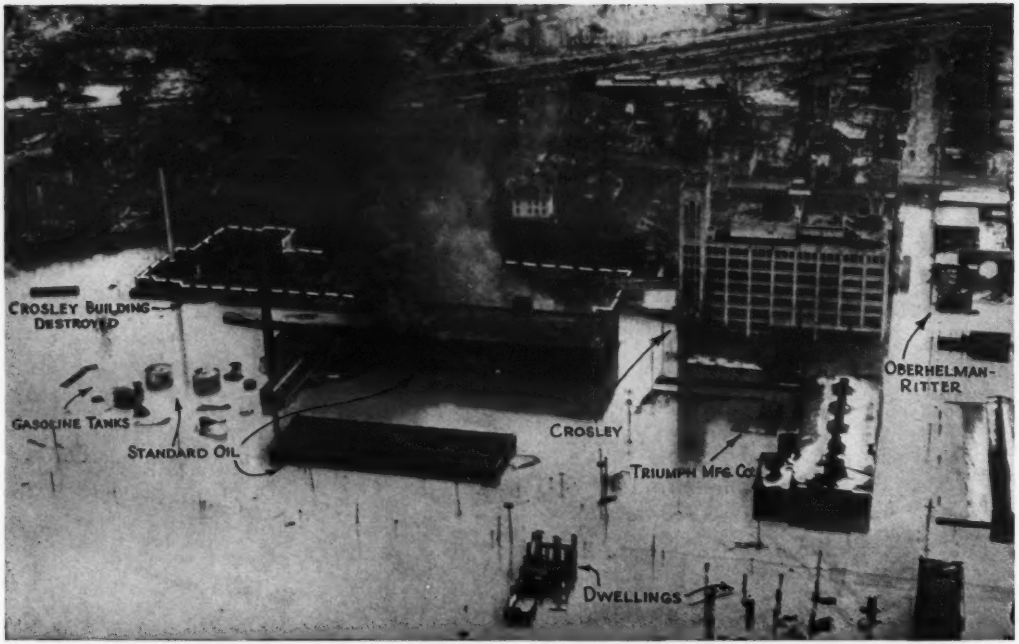


Cincinnati Enquirer.

Interior of the main pumping station at Cincinnati after the waters receded. These large triple-expansion pumping engines were put out of service for lack of steam when the boilers were flooded.

A gallant fight had previously been made by waterworks employees with sand bags and other equipment to keep the pumps running as long as possible. The available water supply in the reservoirs that could be distributed by gravity was about 140,000,000 gallons, which would normally be consumed in three days.

The electrical generators of the utility company were also put out of service on Sunday, January 24. The employees of the Cincinnati Gas & Electric Co., working with sand bags and pumps, lost a hard fight against the rising flood. The city was not entirely without electrical current, because of interconnections with other municipalities, but the service suffered a drastic reduction which put the electrical transportation system out of action.



Factory Mutual Record.

The Cincinnati gasoline fire on the second day, showing the locations of the various properties involved.

The Disaster Council.

A Disaster Council of City and welfare officials was formed with the City Manager as administrator and its first action was the declaration of emergency holidays. Effective plans were soon in operation to cope with the many flood problems. The municipal departments were well coordinated after ten years of operation under a city manager form of government. The citizens were on the alert and responsive under the Manager's leadership, which resulted in strict obedience and general self-sacrifice. The 50,000 inhabitants who were forced from their homes were given temporary housing without a single death or serious injury from building accidents. The police, fire and other city employees with those of the utility companies, the public agencies and the National Guard worked incessantly and courageously. The telephone, gas and radio services were continued, which compensated for short rations in water and electricity.

As a result of the emergency holidays all business, industry, schools and places of public amusement were closed for lack of adequate water, electricity and transportation facilities. Sight-seeing was forbidden in the flood areas to prevent congestion and interference in case of fire. The public water supply was soon supplemented by deep well pumps from local industrial and adjoining municipal sources to the extent of 13,000,000 gallons per day. Additional sources of electrical current were also found which sustained the rationed holiday minimum for public institutional and residential use.

The fire hazard was the chief concern for public safety. The fire alarm system was out of commission in the flood area. The curtailment of electric service resulted in the substitution of every conceivable device for illumination, such as candles, gasoline and kerosene lamps, lanterns and various home-made contrivances. The limited water supply crippled the efficiency of the ordinary means of fire fighting. Fire prevention was therefore stressed at every opportunity.

A large apartment house fire resulted from the use of candles and the firemen laid 5000 feet of hose to the flood area for a water supply. Another fire of considerable magnitude resulted from a salamander in a furniture warehouse, and was fought with flood water from its basement. A wholesale grocery warehouse was destroyed by another salamander fire in an effort to dry out the building after the flood had receded. Numerous smaller fires occurred, but their losses were held to minor proportions. The net result of the flood fires will increase the local per capita fire loss from 60 cents in 1935 and $1.20 in 1936 to an unprecedented figure for 1937.

The Rehabilitation Program.

When the flood waters began to recede, plans were made for an expansion of the building inspection personnel to safeguard a rapid rehabilitation of the

International.

Firemen playing streams upon the ruins of the Stille Duhlmeier Furniture Company factory at Cincinnati, destroyed with a loss of $100,000 on February 5, 1937. Delay in transmitting an alarm because fire alarm circuits were out of service and the lack of water supplies for sprinklers were responsible for the large loss.

9000 flooded buildings. Ten inspection squads were organized from fifteen City building inspectors and fifteen volunteer supervisory employees on local Federal housing projects who were idle because of the emergency holidays. The inspection squads operated under three city building supervisors whose personal approval was necessary on all buildings subject to condemnation or vacation. The latter were buildings that were unfit for occupancy without major repairs or reconstruction.

Electrical inspection has always been an authorized function of the local office of the Ohio Inspection Bureau. Electrical inspections are made for compliance with the National Electrical Code which has been the City regulation under the Building Code for 28 years. Additional electrical inspectors were recruited by the Ohio Inspection Bureau from other cities to provide a total of ten inspectors. No service connections were permitted without an approval of the Ohio Inspection Bureau for electrical wiring and equipment.

Gas inspections are made by the Cincinnati Gas and Electric Co. under building code regulations and in coordination with the municipal building in-

C. M. Stegner.

Ruins of the Mill Creek Valley fire in Cincinnati. In the foreground are the twisted unprotected steel trusses which mark the location of the Crosley plant refrigerator assembly Building K. In the center is the ruined Standard Oil Company warehouse.

spection. A decision was made that no gas or electric service was to be restored by the utility company in any building in the flood area with a "Condemnation" or a "Vacation" sign.

An agreement was also made between the Superintendent of the Ohio Inspection Bureau, the Superintendent of Electrical Distribution of the Cincinnati Gas & Electric Co. and the Commissioner of Buildings as follows for the flood area:

(1) Before replacing meters for residential service the utility employees were to check the main line and branch fuses, replacing them if necessary. All wiring could not be inspected during the emergency, but if defects were apparent or indicated by repeated blowing of fuses, no service connection was to be made.

(2) On industrial premises, services were to be restored as soon as transformers and entrance equipment could be had. The utility employees were to check the voltage as restored to the line side of the main line switch where their responsibility ended. Restoration of defective work was subject to the approval of the Ohio Inspection Bureau as heretofore.

The preceding conclusions were based on the theory of more danger from fire if the service restoration was delayed than from defective wiring if all circuits were properly fused. Without service, the customer might use oil lamps, candles, etc., which would create potential fire hazards. It was also desirable to get the residents back into their homes as soon as practical in order to discontinue the overcrowded refugee establishments. The wisdom of these conclusions was verified by the results wherein fires in the rehabilitated buildings were not much above normal.

The flood receded almost as rapidly as it came up. It rose eight days from 52 to 80 feet, was stationary one day on January 26 and returned to 52 feet nine days later on February 5. The emergency holidays started on January 25 and were terminated on February 4 — a period of ten days.

Water, electric and street car service was again restored. The National Guard was demobilized on February 5, when 7000 residence buildings in the flood area had been given a preliminary inspection. Of these 130 were condemned, 340 were ordered to be vacated and 150 were found to have been damaged beyond repair or to have floated away. Most of these were small frame buildings. During the following week 2300 business and industrial buildings were given preliminary inspection, which resulted in nine building condemnations and 43 orders to remove sheds and minor accessory structures.

By this time work had been resumed on the Federal housing projects and our volunteer building inspectors were back at their regular employment. The rehabilitation work in the flood area was well under way and water had drained from most of the basements. A more complete reinspection of all flooded buildings was started by the regularly employed city building inspectors. Written orders were sent for all condemnations, vacations and other necessary work. Compliance with these orders will require considerable time because many of the owners have no financial resources and their property is mortgaged to the limit.

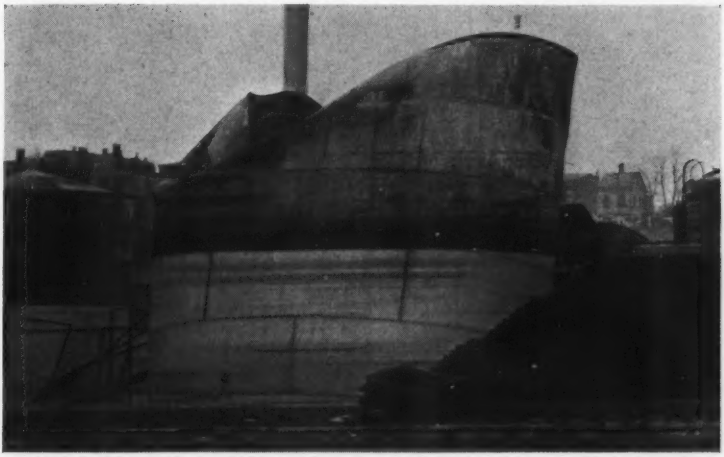
Special attention is to be given to cleaning up flooded districts in the Spring Clean-up Campaign during the first week in May. More than 50,000 truck loads of rubbish and débris have been taken out of flooded areas, but owners of hundreds of places where tenants abandoned goods and chattels in rented houses have made no provision to clean up the premises.

Safeguarding of Oil Storage.

Plans were soon under way to improve the municipal water works and the generating station of the Cincinnati Gas & Electric Co. so as to prevent a repetition of the 1937 flood disasters. Other plans are being formulated to improve the flammable liquid container regulations, so as to make them flood proof, if possible. Failing in this the only alternative is the prohibition of flammable liquid storage in the flood area.

The chief safeguard in time of flood is loading the tanks with flammable liquid or water and then providing such additional means as are necessary to prevent floating and collapse. Provision must also be made to resist the current and the impact from floating objects. This involves too much reliance on the human element to maintain the equipment in good working order and then to operate it with a sufficient degree of safety to insure the general public welfare.

A proposed ordinance has been drafted along these lines. The above-ground tanks, after being loaded with flammable liquid or water, must provide the additional safety requirements by (a) floating in vertical guides, (b) a location elevated sufficiently to have the top of tank 30% of its height above the maximum flood stage, and (c) anchorage. Underground tanks with liquid



Standard Oil Company of Ohio.

A remaining portion of the dike wall which surrounded the Standard Oil plant at Cincinnati prior to the flood. During the night of January 22nd, the flood caused the collapse of a large portion of this wall. The area within the dikes is several feet below the street level and soon the tanks were floating and gasoline was released from broken connections. All day Saturday gasoline vapors pervaded the atmosphere in the vicinity and were ignited by an electrical spark on Sunday morning.

loading must have additional anchorage and strength to resist the hydrostatic action of a maximum flood stage.

Safe practice requirements are then prescribed for filling the tanks when the flood waters reach a prescribed stage, for disconnecting supply lines of floating tanks, for keeping all tanks filled during the flood period and for having all connections tight to prevent the loss of gasoline. The enforcing provisions include an annual license fee and a bond for persons owning or operating flammable liquid tanks in the flood areas.

The terms of the proposed ordinance are not fully acceptable to the local oil industry. It has not, as yet, submitted a more satisfactory alternative that will adequately safeguard the public welfare. The local zoning regulations have established precedents for similar cases by excluding objectionable industries from certain localities or from the entire city where the nuisance or fire hazard problems cannot be economically solved. River sites are choice locations for local bulk gasoline storage tanks because of low river transportation rates. Their conflagration hazard on the other hand may more than offset the benefit of such rates.

External Drenchers.

By Ernest C. Prince, A.C.I.I., A.C.I.B., A.J. Inst. E., of Lloyd's Syndicates' Survey Dept., London, England. (Member N.F.P.A.)

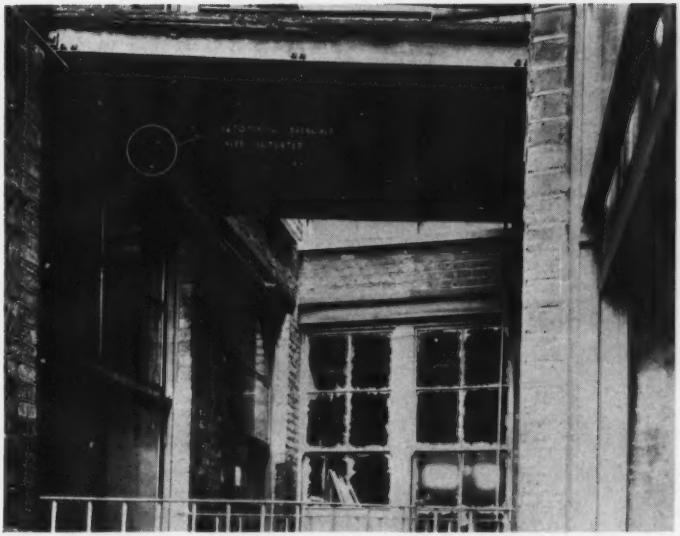
There are two systems of external fire protection by water curtains in use in Great Britain, manual and automatic, both commonly referred to as external drenchers. The Fire Offices' Committee sets the rules for installation quoted herein. They require that all combustible parts of walls and roofs be protected by open or unsealed drencher heads of an approved pattern, conforming broadly to the open sprinkler used for external protection in the United States. Every window or other opening in the two topmost stories must be fitted with a drencher or drenchers, and the same applies to openings in each alternate story below this level except ground floor and basement. Drenchers must be so fixed that the streams form a water curtain, which must come into contact with the window two feet from the top. Skylights and other openings in roofs must be similarly protected. The rule applies whether or not the openings are protected by fire-resisting shutters or doors.

The roofs must be protected by a line of drenchers spaced not more than 8 feet apart along the apex. This is also the spacing commonly required for drenchers below the eaves or where openings or combustible materials in walls or roofs exceed 8 feet in width. Drenchers nearest the edge of a protected area must not be more than 4 feet therefrom. Windows which are separated from each other by less than two feet of incombustible material may be deemed and protected as one window, provided a drencher can be fixed in such a position as to command the whole of the openings.

The vertical feed pipe must rise to the level of the highest drencher in the section supplied. It shall be equipped with a control valve at the base. No one such valve shall control more than 72 drenchers. The drencher equipment may be divided either vertically or horizontally into sections to suit the exposing hazard, but not more than twelve drenchers may be fixed on any horizontal line of pipe, and not more than six on one side of the vertical feed pipe.

All roof drenchers and the two top rows on the face of the building must have a $\frac{3}{8}$-inch waterway to each head, while the remainder have a $\frac{1}{4}$-inch waterway. No feed pipe smaller than 1 inch may be used in Great Britain. Otherwise pipe sizes approximate closely to the U. S. standard.

The installation is required to have a direct connection with an approved and practically unlimited supply of water which must, when the valve is fully open, give a pressure of at least 5 pounds to the square inch at the level of the highest drencher. An attachment, clearly indicated by a wall plate, must be provided to the installation to enable the fire brigade to couple up, and



Fire coming from windows at the right caused the operation of the automatic drencher head, marked with a circle, located over the window at the left, protecting this window. Windows shown in the center were unprotected by drenchers and were broken by fire, although a greater distance from the original fire.

pump water into the system. Where the whole drencher equipment comprises more than 55 heads, there must be at least two hose attachments of not less than two inches internal diameter on a four-inch pipe. For smaller systems, one such opening on a three-inch pipe will suffice.

In installations of this type, since water is kept back by the main stop valve, which has to be opened by manual effort at the time of a fire, all pipes beyond such valve are normally empty. Dust and refuse tend to accumulate in the heads and small bore pipes, and in the course of time are liable to form an obstruction that might render several adjacent drenchers ineffective, and leave an expanse of wall entirely unprotected by the water curtain. For this reason they must be tested periodically.

Most of the open drenchers in Great Britain were erected between about 1900 and 1910, when so many warehouses in the city of London were first protected by internal automatic sprinklers, and it was necessary, owing to narrow streets and opposing contiguous property, to protect the sprinklered buildings from fires arising in other buildings. Although no hard and fast rule is laid down, it is usual to require drencher protection where the opposing buildings are situated within 20 feet, the one from the other.

At a later date, the London County Council Fire Brigade became empowered under the London Building Act to demand the provision of sprinklers in the case of newly-erected buildings with a cubic capacity exceeding 250,000 cubic feet. It now stipulates that the external drenchers shall have the characteristics of a sprinkler installation of the alternate wet and dry pipe system. This compulsory fitting of sealed external drenchers is confined to the area governed by the London County Council, and does not extend over the country generally.

The reasons advanced for this variation in the former practice are:

(a) Rapidity of action (being automatic and therefore independent of manual control).

(b) Conservation of water (only those heads opening where the actual danger lies).

(c) Certainty of action (no failure from clogging by dust, rust or other foreign matter).

An objection raised against (b) is that if automatic drencher heads in the higher portions of the building opened, the water coming down, while insufficient to thoroughly drench the lower window openings, would be liable to keep lower ranges of heads cool enough to prevent their opening. The Fire Brigade replies that if the water released prevents the lower heads from operating, it will by that very fact keep the fire out of the protected building.

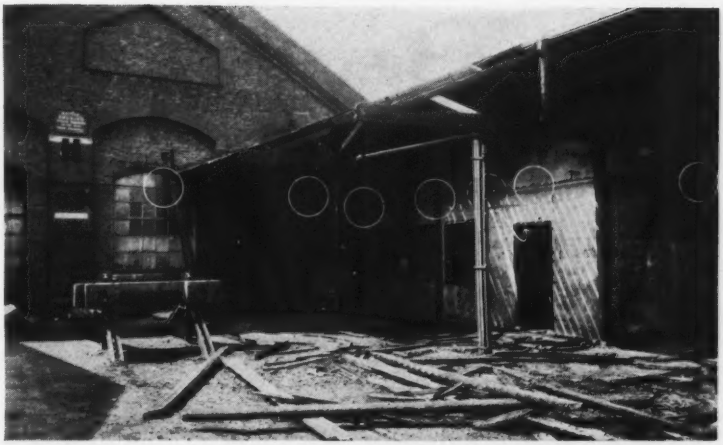
On the 28th of June, 1936, the first automatic drencher actuation in London occurred at a soft goods factory in a very confined situation. The drencher was installed protecting the opening at one end of a bridge between buildings. It successfully protected ordinary glass against exposure that was sufficient to shatter completely a near-by unprotected window.

On August 22, 1936, fire in a tarpaulin depot railway yard was successfully prevented from entering openings protected by sealed drenchers. Seven drenchers actuated in this case.

The first sealed drencher installation in London was erected at the Corwall Press about 1922, but insofar as the writer is aware, has never been called upon to operate. To refute suggestions that the outside sprinklers might become insensitive in the course of time, the fire brigade removed several from the Press some little while ago and submitted them to test. The heads were found to function at from 10° to 15° above the predetermined temperature.

The Fire Brigade have on record at least one instance where automatically operated, fire-resisting shutters functioned before the open drenchers protecting the same property could be put into action. This is felt to conclusively endorse the policy of automatic sealed heads for external protection.

Where the window openings are few or the available water supply does not justify the separate connections normally demanded for sprinklers and drenchers, the Fire Brigade permits that the internal sprinkler installation



Fire which destroyed a tarpaulin depot railway shed on August 22, 1936, was prevented from entering openings protected by the operation of seven sealed drenchers.

may be extended to the inner side of the windows where drenching is necessary. A sprinkler with a deflecting plate is fitted immediately in front of each such window. In the event of a fire in an opposing building diffusing sufficient heat to shatter the glass of protected buildings, these heads open automatically and a curtain of water is directed so as to safeguard the window opening.

This is claimed to be as effective as an outside drencher, with the advantage that water is not sprayed on lower drenchers to keep them from opening. The controlling authority is, however, reluctant to grant permission for this modified protection on account of the water damage within the building.

An unfavorable feature in the automatic drencher from the point of view of the insuring public is that whereas the owner of the protected property has no option but to comply with the Fire Brigade requirements, the insurance companies subscribing to the Fire Offices' Committee do not recognize the sealed head for the discounts they are prepared to concede for the open drenchers.

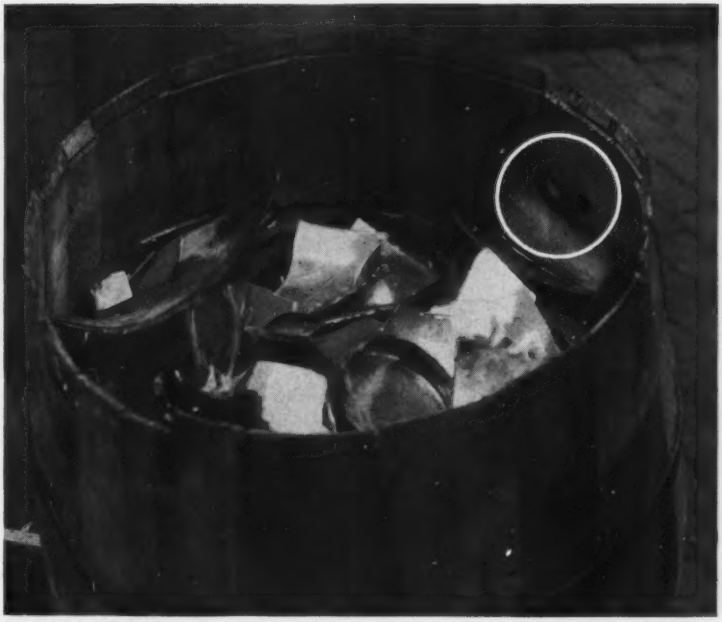
The Sun As a Fire Cause.

Under certain conditions the sun presents a definite fire hazard. The N.F.P.A. Department of Fire Record receives reports of fires caused by the sun in combination with various other factors at the rate of two or three a year. It is very probable that many other fires, the causes of which have not been detected, were started in this way. A piece of glass dropped in a forest might, on a hot, dry day, start a forest fire that would burn thousands of acres and never be explained.

The following tabulation has been made from reports received from various sources by the Department of Fire Record, of the 33 fires where the ignition was definitely attributable to the sun's rays.

Fires Caused by Sun's Rays.

I.	Direct sun rays ignited		4
	Chemicals for fireworks in pans outside building	1	
	Pyroxylin cargo of steamship by heating steel decks	1	
	Lacquer dust on driveway of factory	1	
	Bottle of wood alcohol on porch of home (Burst and ignited)	1	
II.	Sun shining through window glass ignited		13
	A wooden table	1	
	Fireworks in display window	2	
	Photographic film	2	
	Hanging tobacco, being dried	1	
	Mattresses and upholstery	1	
	Matches left on window sill	1	
	Paper	1	
	Pyroxylin fountain pen	1	
	Unknown flammable materials	3	
III.	Through glass bowls, bottles, etc.		9
	Shining through vinegar bottle, ignited mail pouch on truck	1	
	Through jug of water ignited:		
	Shingled side of house	2	
	Tarpaulin	1	
	Through goldfish bowl ignited:		
	Curtains	2	
	Upholstered furniture	1	
	Threads of tarred jute (plumbers' workshop)	1	
	Pair of mittens	1	
IV.	By reflecting agents, mirrors, etc., ignited		4
	Show case in drug store window	1	
	Fireworks in store window	1	
	Paper box, from reflector of an electric heater	1	
	Wooden barrel from broken glass reflectors	1	
V.	Miscellaneous		3
	Shining through magnifying glass ignited pyroxylin visor on cap	1	
	Scrap film in film laboratory focused on and ignited itself	1	
	Glasses in man's pocket focused sun on pyroxylin comb	1	
	Total		33



Factory Mutual Record.

Broken glass reflectors had been placed in a wooden barrel in the yard of a glass factory at Corning, N. Y., pending removal. On a hot July day the rays of the sun striking one of the pieces were reflected to the side of the barrel. At the point where the rays focused a hole was burned completely through. Attention is directed to this hole in the above photograph by the white circle around it.

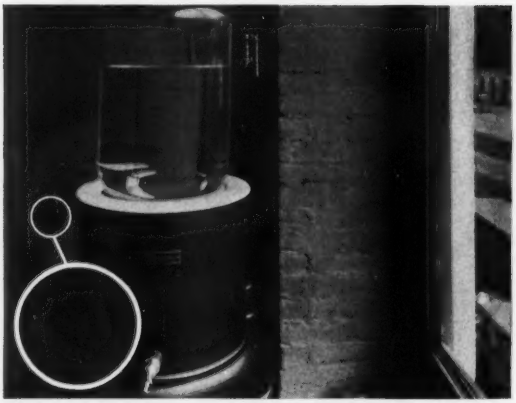
Typical Fires.

JUNE 17, 1864, WASHINGTON, D. C. Metal pans containing chemicals for the manufacture of fireworks were placed outside in the sun near a cartridge factory. The sun exploded them, and the fire spread into the cartridge factory, burning to death twenty women employees. (H-35900.)

APRIL 12, 1922, HOLLYWOOD, CALIFORNIA. The rays of the sun shining through a pile of scrap film started a fire which damaged a film laboratory to the extent of $20,000.

MAY 15, 1922, MONTREAL, P. Q. The sun shining through the wired glass window of a macaroni factory focused on and ignited a table. The fire was extinguished by sprinklers with small loss. (S-32208.)

JUNE 18, 1925, MADISONVILLE, KY. Tobacco leaves hung up to dry in the hanging room at the top floor of a tobacco factory were ignited by the extremely hot sun shining through skylights. The dry tobacco spread the fire rapidly through the building, which was soon a total loss. (H-22339.)



The sun's rays shining through the glass bottle of a water cooler charred a near-by wooden partition. Prompt discovery prevented a serious fire. The insert shows a close-up of the charred section.

MAY 18, 1926, SPRINGFIELD, MASS. Lacquer dust passing out through the exhaust duct of an electric appliance manufacturing plant accumulated on the driveway where it was ignited by the hot direct rays of the sun. (S-42451.)

SEPT. 18, 1926, THIEF RIVER FALLS, MINN. A truck carrying a mail pouch and a gallon jug of vinegar was left standing in the sun. The sun's rays shone through the jug and produced enough heat to ignite the pouch which was rapidly consumed. (H-23818.)

OCT. 12, 1927, SALEM, MASS. Fire started in the window of a store when the sun was reflected and focused on a paper box by the reflector of an electric heater. It was quickly extinguished. (H-25072.)

JULY 30, 1930, CLINTON, MO. A man set out for a walk with a pair of glasses and a pyroxylin comb both exposed to the hot sunlight in his pocket. The sun focused through the glasses on the comb and ignited it. (H-33884.)

FEB. 17, 1932, EMERYVILLE, CALIF. Under the influence of sun's rays coming through a window a pyroxylin fountain-pen in a desk set holder caught fire and burned with an intense flame that ignited surrounding articles. The loss was $122. (S-62108.)

MAY 27, 1933, TORONTO, CANADA. Although the sun had been shining but a few minutes through the window of a fireworks store there was sufficient heat to ignite the firecrackers on display. The damage to the buildings and loss of contents amounted to $2200.

NOV. 4, 1934, PENN YAN, NEW YORK. The sun focused through a gold fish bowl on a pair of mittens in a dwelling. The mittens were ignited and the fire spread rapidly, doing $500 damage. (H-39066.)

SEPT. 22, 1935, ORLEANS, MASS. A jug of water on a back porch proved a magnifying glass through which the sun started a fire. Shingles ignited and the fire swept up the side of the house, doing $200 damage. (H-40758.)

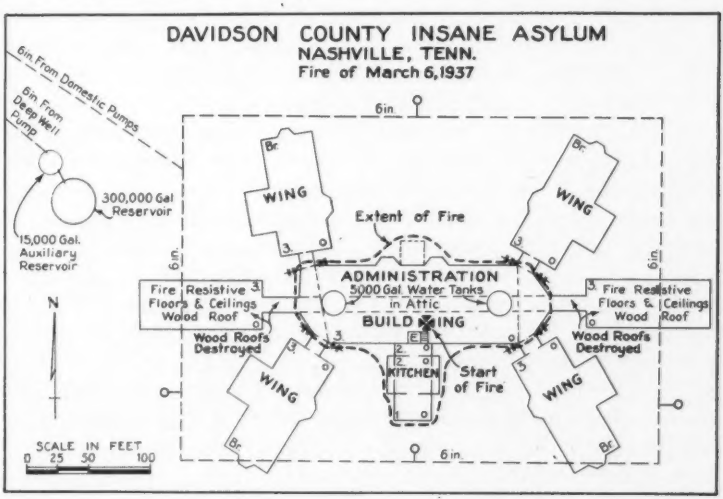
Insane Asylum Fire, Nashville.

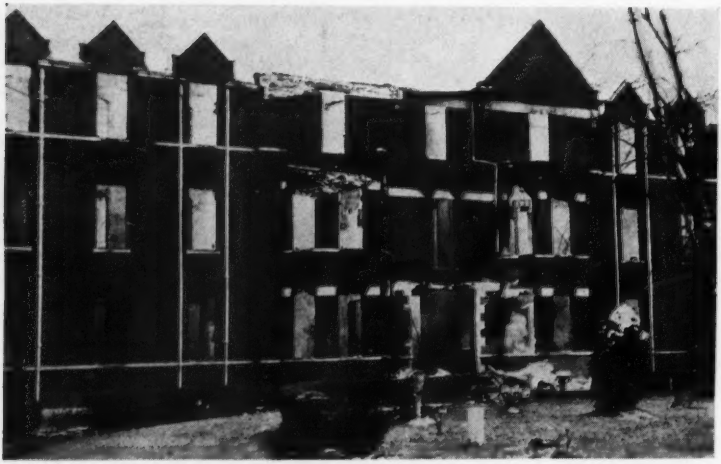
Report by Tennessee Inspection Bureau,
(Member N.F.P.A.)

Four hundred and ten inmates were driven out into the cold when a fire of undetermined origin destroyed the Administration Building of the Davidson County Insane Asylum at Nashville, Tennessee, early on the morning of March 1, 1937. This fire showed the need of adequate private fire protection facilities for institutions and the importance of parapets extending through the roof to prevent the spread of the fire through combustible attics. The total loss was approximately $125,000.

Construction and Occupancy.

The asylum consisted of a three-story brick administration building and six wings. Two of the wings were of fire-resistive construction, with the exception of wooden roof construction. The other four wings were of ordinary brick construction. All of the wings communicated with the administration building through brick and fire-resistive passageways with unprotected openings. Parapeted brick walls extended above the roofs where the passageways from the four wings of ordinary brick construction connected with the administration building. These parapets were factors in preventing the spread of the fire to the four brick wings. There were no parapets above the roofs of the passageways from the fire-resistive wings. The administration building was





International.

The ruins of the central Administration Building of the Davidson County Insane Asylum at Nashville, Tenn., destroyed early on the morning of March 1, 1937. Four hundred and ten patients housed in six wings of the structure were removed without injury.

occupied by the office and quarters of attendants. The wings housed the inmates.

Story of the Fire.

About 3:45 A.M. on March 1, 1937, an attendant, whose quarters were on the third floor of the administration building, noticed a light in the hallway. An investigation was made which resulted in detecting a fire in the attic through a glass transom over the door to the stairway leading from the third floor to the attic. Two night watchmen were on duty. One was in the main office on the first floor and the other had completed his round shortly before the fire started and was caring for some of the patients in one of the wings. Upon discovery of the fire a local alarm was sounded and several attendants using fire extinguishers and standpipe hose fought the fire from the third floor through the transom over the door. No attempt was made to enter the attic, as the one stairway provided the only entrance. An alarm was telephoned to the Nashville Fire Department at 3:53 A.M. and two pumpers and the assistant chief responded. A second alarm was turned in at 4:11 A.M., bringing one additional pumper and the fire chief.

When the fire department arrived the entire administration building was in flames. Firemen and attendants herded the inmates from the wings into the yard, from which they were subsequently taken to the near-by County Poor Home. In fighting the fire, hose was attached to a private hydrant on the north

side of the administration building and pumpers took suction from the 300,000-gallon underground reservoir at the asylum. Two 5000-gallon steel water tanks located in the attic of the administration building, and used to supply standpipes and hydrants, fell through floors to the basement, breaking water pipe connections. After this all water was taken from the underground reservoir which was replenished by a 15,000-gallon auxiliary reservoir near by, which was kept filled by a deep well pump.

Firemen, handicapped by poor water facilities, attempted to confine the fire to the administration building, but about 6:00 A.M. flames carried by an easterly wind ignited the wooden roof of the east fire-resistive wing. Half an hour later the wind reversed and ignited the roof of the west fire-resistive wing. Roofs of the fire-resistive wings were destroyed, but firemen saved the other wings and brought the fire under control about 9:30 A.M.

The cause of the fire has not been ascertained, but it has been suggested that it was due to spontaneous ignition of oily rags or the short circuiting of an elevator motor in the attic.

Mercantile Block Fire, Muskegon, Mich.

Report by Michigan Inspection Bureau,
(Member N.F.P.A.)

A fire of undetermined origin early on the morning of February 6, 1937, completely destroyed a mercantile block in Muskegon, Mich., with a loss estimated at $400,000. In addition to offices and apartments the destroyed block housed two large stores. These were the Kline's Department Store where the fire originated, and Grossman's Dry Goods store. The large loss was largely due to the headway of the fire when discovered, unprotected openings in the brick walls, which divided the block into three main sections, and lack of automatic sprinkler protection. This was the second Muskegon fire within a year to cause a loss of a quarter of a million dollars or more. The fire which destroyed the Occidental Hotel on March 4, 1936, with a loss upward of $250,000 was reported in the April, 1936, QUARTERLY.

Construction and Occupancy.

The buildings in which the fire occurred were one, two and three-story and basement brick-joisted structures with sheathed ceilings also of joisted construction. The buildings covered an area of approximately 24,000 square feet, and formerly consisted of three separate fire divisions separated by fire walls. However, unprotected openings had been made in these brick walls within the past year. After the fire it was apparent that the division wall between Grossman's main store and the central section of the block was pierced by wooden floor and roof timbers. Practically all the floor openings were unprotected.

Radium.

Firemen with a monitor nozzle and hand lines are shown in an unsuccessful attempt to halt the spread of the fire in Kline's Department Store through unprotected fire wall openings to the Grossman Dry Goods Store in Muskegon, Mich., early on the morning of February 6, 1937. A loss of $400,000 resulted.

All floors, including the basement of a two-story section, were occupied by Grossman's store, and all floors and basement of a three-story section were occupied by Kline's store. Each of these stores also occupied half of the basement and first floor of the central section, the upper floors of which contained offices and apartments.

Story of the Fire.

The fire was first discovered by the porter in Kline's Department Store, who smelled smoke while he was sweeping on the third floor at about 2 A.M. Upon investigation he found that the entire basement of Kline's section was ablaze. Escaping from the building he notified policemen, who turned in an alarm at 2:15 A.M. Three pumpers and a city service ladder truck responded, and firemen found the fire burning intensely in the basement and at the rear of the first floor of the same section. Three subsequent calls brought three additional pumpers, and help was called from the Muskegon Heights fire department, which responded with a pumper and flood light equipment. The seven pumpers were used to supply eighteen hose lines, including those supplying a monitor nozzle on the ladder truck.

Radium.

Ruins of the Kline and Grossman stores at Muskegon, Mich. Bricks in the street are from the front wall of Kline's store, which collapsed. The spread of the fire to the left was checked by a blank brick wall of the store shown barricaded with boards.

Soon after the first pumper company laid their lines from a hydrant in front of the central section to Kline's store, it was necessary to move the equipment, and shortly following this the front wall of Kline's store fell into the street. Hose lines were directed against the walls of exposed buildings. An attempt to prevent the spread of the fire through openings in the division walls was unsuccessful, as sections not already burning were so filled with smoke and heat as to be inaccessible to firemen.

Cause and Loss.

The exact cause of the fire is unknown. It may have started in the boiler room or in the basement shoe repair section of Kline's store. In the shoe repair section a buffer exhausted into an unapproved metal can, and hats were cleaned by means of naphtha.

The estimated loss of $400,000 resulting from this fire includes approximately $150,000 damage to the buildings and $100,000 to Grossman's store. While definite figures are not available, it is obvious that Kline's store suffered the greatest loss of any occupant. Smaller tenants also had total losses.

Fire Record of Household Refrigerators.

Mechanical household and small mercantile refrigerators have been in quantity production in the United States for about fifteen years. The total number of sales through 1935, as compiled by "Air Conditioning and Refrigeration News," including some sales for export, was 8,963,600, and the total sales value $2,069,202,600. The production is continuing to increase rapidly. For the first eleven months of 1936, according to the National Electrical Manufacturers' Association, the number of electric household refrigerators sold was 1,956,327. Only about 10% were replacement sales. The estimated saturation of the market in 1936 was reported by *Electrical Merchandising* to be 34.2%, or 7,250,000 of the 21,204,354 wired homes equipped with electrical refrigeration.

Types of Refrigerators.

Household refrigerators can be classed in two general groups — the compression type and the absorption type. The compression type has continued to be by far the more popular. In these refrigerators the extraction of heat from the air in the box is accomplished by allowing a liquid of low boiling point to evaporate and expand in the cooling unit located in the ice compartment of the box. The gas resulting from the evaporation is carried by connecting tubing to an electric motor-driven compressor or pump which compresses the gas to such a pressure that it will condense to the liquid state at the temperature of the condenser coils. The liquid is returned to the container in the ice compartment to re-evaporate, and the cycle is repeated. When the refrigerator has been cooled to a predetermined point, the current is cut off by a thermostatic control switch until sufficient heat has entered the box to cause the control switch to close the electrical circuit and start the refrigerator.

It is estimated that not more than 5% of all automatic household refrigerators are of the heat absorption type. In these machines refrigeration also depends upon the evaporation of a liquid refrigerant. The evaporation is caused by reducing the pressure above the liquid by absorbing the vapor or gas given off from the liquid. The gas is then driven off from the absorbing medium by heat and passed through a condenser which reduces it to the liquid state. It is then re-evaporated in the cooling unit and the cycle is repeated. The heat necessary for the process is supplied by a gas or kerosene flame, or in a limited number of cases by an electric heater. While the heat process has not figured in any of the fires reported to the N.F.P.A. Department of Fire Record, it involves the usual hazards of heating devices, to be safeguarded by well-established principles.

Hazards of Refrigerating Machines.

The first hazards of the compression type of refrigerator to be considered are the fire and accident hazards due to the presence of electricity. When mechanical refrigerators were first being widely distributed, the hazard of the motor was considered negligible. It is, in general, a motor of fractional horsepower taking a very small current. However, experience has shown that such mechanical equipment is a hazard in the hands of the average householder or shopkeeper. Any motor may overheat and become a fire hazard when overloaded or short-circuited while not supplied with adequate fuse protection. At the end of 1934 there were 345,000 household and 116,000 commercial refrigerators in New York City. This number has probably increased considerably for the year 1937. According to reports of the New York Fire Patrol, the fire department made thirty-six runs to fires in refrigerator motors in the three months January, February, and March 1937. Of these fires, eight had extended from the motor to walls, partitions, or other near-by woodwork. It is most probable that the majority of these fires were not in motors protected according to the National Electrical Code rule, which requires running protection of not over 140% of the rated current of the motor on all automatically started motors from ⅛ to 1 horsepower. The most modern form of protection is a thermal cut-out built into and forming an integral part of the motor.

The *News Bulletin* of the International Association of Electrical Inspectors published in its March, 1937, issue a tabulation of 55 fires in domestic refrigeration motors due to overload. Two were caused by failure of the starting mechanism, four by locking of the belt or compressor, and forty-nine by an unknown overload. In thirteen of the fires the fuse protection was known to be standard, in one case over, and in forty-one cases it was not determined. Thirteen of the fires extended beyond the motor. The N.F.P.A. Department of Fire Record has reports from various sources of 88 refrigerator motor fires of which 16 extended beyond the motor. In most cases serious damage did not result, even where the fire was not confined to the motor. The most serious damage caused by a fire definitely attributed to a refrigerator motor occurred in Lafayette, La., on April 27, 1931. A man awakened at 5:00 in the morning to find his house full of smoke and sulphur dioxide fumes from a fire burning in back of the refrigerator evidently started by the motor. He was able to escape before being suffocated, but the $4500 frame house was nearly a total loss. (H-33122-A.)

There is also the hazard of the wiring to the motor to consider. A fire in Pawtucket, R. I., on March 24, 1934, resulted from wiring to a mechanical refrigerator motor. The fire burned out the interior of a restaurant with a loss of $2484. (H-39570.)

To protect against the electrical hazards, the motor, wiring, and control switch must be examined and tested. The motor must withstand insulation

and heating tests; the wiring must be of adequate size and properly insulated and protected; and the control switch must withstand a repeated operation test, be constructed of suitable material, and its parts must be properly spaced and insulated.

The second and more serious hazard of refrigeration machines is that due to the gas used as a refrigerant. The most frequently used of these is sulphur dioxide. Of the 461,000 mechanical refrigerators in New York City at the end of 1934, 399,000 used this gas as a refrigerant. From a standpoint of fire hazard alone, sulphur dioxide is not dangerous. It is not flammable. It is, however, an indirect fire hazard in that it is extremely irritating and its liberation at a fire retards fire fighting. The N.F.P.A. Department of Fire Record has reports of 11 fires where escaping sulphur dioxide was responsible for greater fire loss.

In the fire reported above at Lafayette, La., the householder was unable to fight the fire when is was confined to the area behind the refrigerator because the sulphur dioxide made it impossible to breathe the atmosphere.

In Bakersfield, Calif., June 15, 1928, a fire started in the basement of a candy store, involved the refrigerator, and liberated large amounts of sulphur dioxide, making the fire very difficult to fight. Twenty-six firemen and four policemen were overcome by the gas during the course of the fire. (H-26186.)

Other common refrigerants that have figured in accidents reported to the N.F.P.A. Department of Fire Record are methyl chloride, ethyl chloride, and iso-butane.

Methyl chloride is both flammable and explosive (but only moderately so) when mixed with air in suitable proportions. In contact with flame or hot surfaces it produces toxic and irritating fumes. Of itself, however, it is somewhat toxic, though having a mild and rather pleasant odor which makes it dangerous in respect to gas poisoning.

As an example of fire accidents possible with this gas, on June 26, 1929, there was a fire in a unit refrigerator in an apartment in Baltimore. A repairman was installing a new compressor. He used a candle to see under the machine, and the flame ignited escaping methyl chloride. The flame continued in the escaping gas and resulted in a very hot fire that did considerable damage before being extinguished by the fire department. (H-27865.)

In 1929 the use of methyl chloride in refrigerators was restricted in Chicago as a result of several cases where the escaping gas caused fatal poisoning.

Ethyl chloride is flammable and forms explosive mixtures with air in certain proportions. Its hazards are similar to those of methyl chloride.

On July 19, 1926, in Hartford, Conn., a repairman was working on a mechanical refrigerator in a multiple system using ethyl chloride as a refrigerant. He removed the top of the gas chamber, allowing the gas to escape

into the room. It was ignited by a gas range pilot light and flashed over the room, fatally burning the man and seriously damaging the apartment. (H-23553.)

Iso-butaine is a flammable and explosive gas comparable to gasoline vapor. On September 5, 1930, in a resort hotel at Saratoga Springs, New York, a man was fatally burned when he opened the door of a refrigerator employing iso-butane as a refrigerant and was met by a series of small explosions. Escaping gas had been ignited by a near-by gas stove. (H-57699.)

Ammonia, while a good refrigerant, has been little used in small or unit refrigerator systems excepting the gas absorption type. It has been known to cause explosions and constitute a hindrance to firemen where it is used.

On December 12, 1933, in New York City a disused ammonia refrigerator in the basement of a building being demolished exploded due to heat from a bonfire, and metal fragments were projected for a distance of several blocks. (H-38120.)

On November 15, 1929, in Boston, Mass., a fire in a grease flue in the kitchen of a restaurant melted an ammonia refrigerator pipe, and before the firemen could extinguish the fire some of them had to put on gas masks and repair the pipe. (H-29036.)

The fluoro compound refrigerants that have been developed in recent years, such as dichlorodifluoromethane, have not resulted in any accidents reported to the N.F.P.A. Department of Fire Record. They are in general non-flammable. When in contact with flame or hot surfaces they may produce toxic fumes, but the odor gives warning of their presence before a dangerous concentration is reached.

Other refrigerants very little used and for which no record data are available are the highly flammable hydro carbons: ethane, propane, and methyl formate; moderately flammable: dichlorethylene and ethyl bromide; slightly flammable: methyl bromide and methylene chloride; and non-flammable: carbon dioxide.

Some household mechanical refrigerators are equipped with a hermetically sealed motor housing. The Department of Fire Record has reports of three fires where such an installation, though using non-flammable sulphur dioxide refrigerant, has exploded, doing considerable damage.

In a New Orleans dwelling, September 28, 1936, a householder saw flames coming from the top of her refrigerator. As she went to turn off the switch, an explosion occurred which blew off the heavy metal refrigerator top. It tore a hole in the side of the house, glanced through a window, hit a fence, and bounced back through the window into the room. Firemen experienced difficulty in getting into the house due to escaping sulphur dioxide. The cause of this explosion is not definitely known. It is thought that perhaps the bearing grease was vaporized due to overheating of the motor and reached explo-

sive concentration in the sealed chamber. It is also possible that the compression chamber burst. (H-41498.)

A second fire occurred under identical conditions and was also unexplained. In this case the sealed enclosure over the motor ruptured, tore the top and one side off the refrigerator, broke a hole in the ceiling and caused other damage. (H-41497.)

The third explosion tore the steel casing off the motor and lifted the top from the refrigerator. The casing tore a hole about one foot in diameter in the kitchen ceiling and an irregular hole about one foot in length through the plaster partition wall in the kitchen. (H-39518.)

The refrigerators involved in these three explosions were all of a make not listed by Underwriters' Laboratories, Inc.

In publishing this fire record, it is not the intent to discourage the use of household automatic refrigerators. Considering the vast number of these machines in use, to date their fire record has been exceptionally good. Nevertheless, the fires that have taken place and other occurrences such as leakage of refrigerants resulting in driving people from buildings and in some instances, serious casualties, make adequate safeguards a matter of first importance. Such safeguards are now incorporated in the design of the majority of the refrigerators generally sold, and are evidenced by the listings of Underwriters' Laboratories, Inc.

Two Ontario Hotel Fires.

By W. J. Scott,
Provincial Fire Marshal,
(Member N.F.P.A.)

During the month of January, 1937, two very similar large loss hotel fires occurred in the cities of Sudbury and North Bay in the Province of Ontario, Canada. The two fires illustrated conditions found in many of the smaller cities in Canada and the United States. These conditions include extremely combustible construction, contributing to the very rapid spread of fire; the occurrence of the fires at an early morning hour; and the utter inadequacy of the public fire protection to cope with serious fires. By a narrow margin in each case no lives were lost. In the Sudbury fire a considerable delay in summoning the fire department was an important factor in the destruction of the building.

New American Hotel, Sudbury.

Early on the morning of January 10, 1937, fire completely destroyed the New American Hotel at Sudbury, Ontario, with a total loss of approximately $180,000, which included the destruction of stores occupying the ground floor. Several of the sixty-two persons in the hotel had difficulty in escaping.

Construction and Arrangement.

The outer walls of the hotel were partly solid brick and partly brick-veneered. The interior was of ordinary joist construction. The original portion of the building was built over forty years ago and additions have been made in the intervening interval. The building had a frontage of 120 feet and a depth of 86 feet and comprised one fire area without fire walls. The construction was such as to facilitate the rapid spread of fire horizontally and vertically along open channels.

The building was three stories in height. The first floor, in addition to the hotel lobby, office and beverage room, contained four tenant stores and a Chinese cafe. The upper floors contained two ladies' beverage rooms and guest rooms. In the basement the furnace and coal rooms were located under the rear of the cafe and were separated from other sections of the basement by a brick wall.

Discovery of the Fire.

On the night of the fire a night clerk and a porter were on duty. The porter had been down to the furnace about 4:30 A.M., but had not noticed any signs of fire. At 5:10 A.M. a policeman called to see the night clerk. He commented on a peculiar odor which he thought to be the odor of fire or

smoke. When mentioned by the policeman the night clerk also detected an odor which he thought was gas. He did not suspect fire or smoke. The two men went to the second floor and asked the porter to look at the furnace. The porter found no smoke in the furnace room. He did smell something like smoke around the coal bin, but did not see any fire. When he reported to the policeman that there was something like smoke in the cellar, the policeman went to the cellar of the hotel with him and looked around with his flashlight. This was in a part of the cellar that was cut off from the remainder and from the coal bin and furnace room by a partition without free openings. They could find nothing, although there was a noticeable odor and haze. The policeman then went out and proceeded on his beat.

After sending the porter to the basement, the night clerk went into the two ladies' beverage rooms and opened a door from each onto a balcony to let what he thought was gas escape. He described the "gas" as being like ammonia. He also opened windows at the ends of the corridors on both of the upper floors. He recognized a faint bluish haze on the second floor, but no thought of smoke entered his mind. When he returned from the third floor the gas seemed much worse. He then awakened the manager of the Chinese cafe to go down and see if there was a leak in the cafe refrigerator pipe lines. When they opened the door from the cafe to the refrigerator section a cloud of smoke rolled out. At last realizing that there was a fire the night clerk shut the door and ran to telephone to the fire department and sound the hotel siren.

At the time that the night clerk and the policeman had first gone to the second floor a guest had come out of his room and walked toward the stairs. He had been awakened by a choking sensation. It seemed to him that some gas such as ammonia had escaped. He noticed a haze in the hall which he assumed to be gas and went to a window for air. He awakened three occupants of near-by rooms, but the odor had not reached their rooms. After about ten minutes he returned to his room and found it partly filled with smoke, which was seeping from below around the floor or baseboard. At this time the hotel manager, who had heard the commotion, appeared. He told the guest that his mattress must be on fire. It was soon obvious, however, that the smoke was from some other source and the guest ran to the stairs and called out an alarm just as the siren started to blow.

After the alarm was sent in, the hotel employees and guests who were awake aroused the other guests. Fortunately all of the sixty-two persons in the hotel escaped without the use of ladders, but there were some narrow escapes. The smoke was so thick on the second floor that it was difficult to read the door numbers. Some of the guests had to get down on their hands and knees to avoid the smoke.

The fire department received the alarm at 5:25 A.M. and arrived with three men on a ladder truck and a motor pumper between 5:29 and 5:30 A.M.

One man remained in the fire station to call the off shift and another fireman on duty went for the fire chief. The three men who responded with the equipment laid two lines of hose, one of which they left for the other men when they arrived. Ultimately other lines were used, but valuable time elapsed before an effective quantity of water could be applied to the fire.

When the firemen arrived no flame was visible, but the fire had spread in concealed channels and had created dense smoke that was particularly severe in the area around the back of the cafe, under which was located the boiler and coal room. The fire gained headway due to the combustible interior construction until the entire structure was destroyed. The fire department was able, however, to save near-by structures, although some plate glass windows across the street were broken.

The Chinese cafe manager had $750 in bills in a drawer of a wooden desk. During the fire a porcelain wash basin fell from an upper floor into the basement and landed upside down on the drawer of the desk, which had also fallen through to the basement, and saved $400 from the fire.

Cause of the Fire.

The damage was so complete that it was at first thought difficult to determine the cause of the fire. Those who suggested that there was an odor of ammonia gas were mistaken, as the only refrigerant in the section near where the fire started was sulphur dioxide. Methyl chloride was used in the beer cooling system in a section away from where the fire started.

Although the night porter had stated that at 5:12 A.M. he saw no sign of fire in the coal room, it appears that the fire was due to spontaneous ignition in the pile containing forty tons of coal. Following removal of débris the fire chief made a detailed examination of the coal pile. This examination disclosed no sign of burning in the top portion down as far as two feet from the floor of the bin. However, at the bottom of the pile, thoroughly protected from the main fire in the building by the layer of unburned coal, there was very definite coking. From observation of samples of this coal that had become coked it is agreed that spontaneous ignition occurred in the bottom of the coal pile and that hot gases filtered up through the coal and set fire to unprotected open joist ceiling over the bin.

Conclusions.

The police officer erred badly in failing to send an alarm to the fire department when he thought that he smelled smoke. The night clerk also made an error in judgment in not calling the fire department and arousing the guests sooner. Even if he did not suspect fire, the sleeping guests were endangered by gas. Several of the guests had to be shaken before they aroused, and in one case a door had to be broken in.

This fire made clearly apparent the inadequacy of the Sudbury Fire Department in both man power and equipment. If any of the guests had happened to be at the windows awaiting rescue the three men would have had difficulty in raising the ladders with safety and the fire fighting would have had to wait. For taller buildings requiring long ladders the fire department cannot raise ladders until the off shift firemen arrive, a contingency which might easily result in loss of life. The ladder truck has insufficient power to carry its load and some of the ladders are in an unsafe condition. Had weather conditions been unfavorable or had a strong wind been blowing at the time of this fire, it seems certain that a conflagration would have resulted, as the fire department did not even have an adequate supply of hose or nozzles.

Following this fire, aided by the efforts of the Provincial Fire Marshal's office, six additional men were added to the department and new equipment is being purchased.

Queen's Hotel, North Bay.

The most disastrous fire in the history of North Bay, Ontario, started on the morning of January 26, 1937, in the Queen's Hotel and destroyed or badly damaged four adjacent buildings comprising a third of a city block. Due to inadequate public fire protection the fire was not stopped until it reached a brick fire wall. As the result of the rapid spread of the fire a number of the

The ornate balconies and brickwork marked the Queen's Hotel, at North Bay, Ontario, as belonging to a period when fire protection received little consideration among hotel builders.

Collapse of the walls of the newer portion of the Queen's Hotel. A drug store located on the first floor of this section was a total loss.

hotel guests were forced out in zero weather partially clad, and several escaped by sliding down ropes which were provided at the windows in accordance with the Ontario law. The loss from this fire was about $200,000, of which $65,000 represented the value of the hotel building and $25,000 the value of its contents. The remainder of the loss was to adjoining buildings.

The Queen's Hotel was a three-story building with walls constructed partly of solid brick, but with the entire central portion of brick-veneer. The building was built many years ago and was one of the landmarks of the city. At the time of the fire there were forty guests in the hotel and a number of employees. The hotel also contained a tenant drug store. A three-story building adjoining the hotel, having a cafe on the first floor and fifteen lodgers on the upper floors, was also destroyed. Another cafe and several mercantile buildings were badly damaged by the fire. Several more buildings suffered broken windows and smoke and water damage.

Story of the Fire.

The fire was discovered by the night fireman of the hotel who had gone to the basement to look after the boiler. This man not only looked after the boiler, but had numerous other duties. On the night in question he had applied fresh coal to the fire about four o'clock in the morning and then went upstairs. When he returned to the boiler room about 4:20 A.M. he found flames run-

ning along the beams over the smoke pipe to a width of seven or eight feet and traveling from the direction of the chimney.

He immediately ran up to the main floor and obtained a 2½-gallon extinguisher and told the night clerk to call the fire department, which was done by telephone at 4:22 A.M. When the first extinguisher was exhausted, the night fireman went to the second floor for another extinguisher, but was unable to re-enter the boiler room due to the dense smoke. He then assisted the night clerk in making sure that the guests had escaped. The night clerk rang the alarm bells and knocked at doors to arouse the guests.

The fire department responded promptly and had water on the fire in less than five minutes, but by that time the fire had made such headway that they were unable to confine it to the building. The total fire department personnel on both platoons consisted of but eight regular members and the chief, assisted by four call firemen. The department had only 3000 feet of first class hose, part of which was at the fire station. It was necessary to send two men of the small crew to get the balance of the hose. During the fire the remainder of the city was without protection.

Cause of the Fire.

It was determined that the chimney and smoke pipe which served the boiler for heating the building had not been cleaned out for at least a year and very probably a considerably longer time. This pipe was some 18 in. in diameter and was about 8 in. below the wooden joist ceiling. It is apparent that the accumulated soot from the soft coal took fire and overheated the smoke pipe and chimney. Fire communicated to the combustible ceiling and concealed wall spaces.

Conclusions.

The danger of neglecting the cleaning of chimneys and pipes and the importance of adequate clearance to woodwork is apparent from this fire. This danger may exist in other similar structures and should be a subject for investigation by fire inspectors.

As in the New American Hotel at Sudbury, Ontario, combustible interior construction with concealed spaces and without fire stopping contributed to the rapid spread of the fire which endangered the occupants.

Due to lack of man power and equipment the fire department was unable to effectively control this fire and prevent its spread to other property.

Fires in Which There Was Loss of Life.

First Quarter, 1937.

Since the publication of the January QUARTERLY, the N.F.P.A. Department of Fire Record has received from various sources 300 reports of fires in which there was loss of life. A total of 808 lives were lost in these fires. During the period the following fires were reported in the United States and Canada, which caused the loss of more than six lives each.

FEB. 6, 1937, LOUISVILLE, KY. A gas explosion and fire wrecked a grocery store and apartments above it, killing ten persons. (See account on page 337.) (H-41522.)

Loss of Life Fires, January-March, 1937.*

This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.

Class of Fire	No. Fires	Men	Women	Children	No Data	Total
Airplane Fires	2	4	0	0	0	4
Apartments, hotels, tenements, etc.	27	20	12	2	0	34
Automobiles, buses, trucks	17	32	11	7	0	50
Gasoline tank trucks	2	3	0	0	0	3
Barns and stables	4	2	0	3	0	5
Boats and ships (including house boats)	3	6	1	1	0	8
Churches	2	1	0	0	1	2
Dwellings—Rural	89	38	36	77	1	152
Dwellings—Urban	86	32	35	57	0	124
Forest or brush fires	1	1	0	0	0	1
Garages	7	7	1	0	0	8
Gasoline filling stations	1	2	3	0	0	5
Gas works	1	2	0	0	0	2
Manufacturing occupancies, misc.	4	7	0	0	0	7
Mercantile occupancies, misc.	7	10	3	1	3	17
Mining property	5	31	0	0	0	31
Oil pipe line	1	2	4	0	0	6
Oil refineries and bulk distributors	2	2	0	0	0	2
Oil well	1	3	0	0	0	3
Out of doors	13	10	1	3	0	14
Prisons	3	3	0	0	0	3
Railroad rolling stock	1	1	0	0	0	1
Schools	1	4	13	277	0	294
Tank Vessels	1	5	0	0	0	5
Miscellaneous known buildings	14	14	7	1	0	22
No data	5	3	1	1	0	5
Totals	300	245	128	430	5	808

*This table is made up from those reports received by the Department of Fire Record between December 18, 1936, and March 31, 1937. A few of the fires included herein occurred prior to December 18, but were not reported until subsequent to that date.

Causes of Loss of Life, January-March, 1937.

Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.

Cause	Men	Women	Children	No Data	Total
Airplane fires	4	0	0	0	4
Automobiles, buses, and truck fires	30	11	7	0	48
Tank truck fires	3	0	0	0	3
Boat and ship fires (including house boats)	6	1	1	0	8
Children alone in house	0	0	23	0	23
Children and matches	0	0	4	0	4
Christmas tree fires	0	0	1	0	1
Clothing ignited:					
Bonfire	6	1	1	0	8
Fireplace	1	3	0	0	4
Furnace, stove or heater	4	17	8	0	29
Smoking (see also smoking in bed)	5	8	0	0	13
Miscellaneous or unknown causes	5	2	2	0	9
Entering or re-entering burning buildings	4	3	1	0	8
Escaping fires—jumped	3	1	0	0	4
Explosions (miscellaneous):					
Blasting powder	1	0	5	0	6
City gas	5	2	1	3	11
Coal gas	0	0	1	0	1
Gas works	2	0	0	0	2
Industrial explosion	3	0	0	0	3
Natural gas explosion	4	13	277	0	294
Propane gas	2	0	0	0	2
Fire fighting—firemen	3	0	0	0	3
Fire fighting—private	1	0	0	0	1
Fireworks	1	1	1	0	3
Flammable liquids and vapors:					
Alcohol explosion and fires	2	0	0	0	2
Automobile collision with gasoline pump	2	3	0	0	5
Cleaning fluid—dry cleaning establishment	2	0	0	0	2
Flue cleaning compound	1	0	0	0	1
Furniture polish vapor	0	1	0	0	1
Gasoline lanterns and stoves	2	0	2	0	4
Gasoline tanks	2	0	0	0	2
Gasoline tank vessels	5	0	0	0	5
Gasoline torches	1	0	0	0	1
Heating gasoline on stove	0	0	4	0	4
Heating kerosene on stove	0	1	0	0	1
Home dry cleaning	0	0	1	0	1
Lacquer thinner or paint remover	3	0	0	0	3
Oil pipe line explosion	2	4	0	0	6
Oil refinery fire and explosion	2	0	0	0	2
Oil stove, furnace, or lamp	3	4	3	0	10
Oil well fires	3	0	0	0	3
Starting fires with gasoline	3	1	0	0	4
Starting fires with kerosene	5	6	9	0	20
Miscellaneous cleaning with gasoline	3	0	0	0	3
Miscellaneous gasoline explosions	6	0	3	0	9
Miscellaneous kerosene explosions	1	2	0	0	3
Forest or brush fires (including fire fighting)	1	0	0	0	1
Illness resulting from burns	0	1	0	0	1
Mine fires and explosions	31	0	0	0	31
Overcome by smoke	8	5	2	0	15
Overexertion, firemen	3	0	0	0	3
Pyroxylin comb ignited in hair	0	1	0	0	1
Railroad fires	1	0	0	0	1

Cause	Men	Women	Children	No Data	Total
Shock resulting from fire	1	1	0	0	2
Smoking in bed	10	1	0	0	11
Traffic accidents—fire apparatus	0	0	1	0	1
Trapped in burning building	48	32	71	2	153
Trapped in incendiary fires	0	2	1	0	3
No data	1	0	0	0	1
Total	245	128	430	5	808

FEB. 14, 1937, LAKE CITY, FLA. Seven persons riding in a sedan which collided with the rear of a truck were burned to death when they were sprayed with flaming gasoline from the fuel tank. (H-41521.)

MARCH 11, 1937, LOGAN, W. VA. Eighteen miners lost their lives in an explosion deep in a coal mine. A gas pocket in the mine was thought to have been ignited in some manner. (H-41518.)

MARCH 18, 1937, NEW LONDON, TEXAS. Escaping natural gas in the basement of a school reached explosive concentration and was ignited by an electric switch. In the explosion, the building was wrecked, and 277 children and 17 adults were killed. (See report on page 299.) (H-41523.)

MARCH 24, 1937, SALEM, ILL. A bus carrying a roller skating troupe suffered a blow-out, crashed into a bridge abutment, and caught fire. An explosion of gasoline from the tank followed. Twenty of the passengers were burned to death. (H-41520.)

MARCH 25, 1937, JERSEY CITY, N. J. Trapped in a three-story frame dwelling through which fire spread very rapidly, a man, a woman, and five children were burned to death. The cause of the fire was undetermined. (L-3862.)

MARCH 27, 1937, DUBOIS, PA. Three men were making rock tests in a coal mine. Two others went down to do some dynamiting. The three making inspection heard an explosion and rushed out of the mine. With four others they returned to search for the dynamiters. Just as they reached their bodies another explosion killed the seven rescuers. (H-41519.)

Several outstanding loss of life fires outside the United States and Canada have been reported for this quarter. These are not included in the tables, but are reported here as a matter of interest.

DEC. 22, 1936, ROSITA COAHUILA, MEXICO. Sparks from an unknown source are thought to have ignited fire damp and caused the explosion in which 47 or more miners were killed in a Rosita coal mine.

JAN. 17, 1937, SHEKLUNG, CHINA. Approximately one hundred persons were burned to death in a railroad train en route from Canton to Hongkong, when an explosion of sulphuric acid set fire to the last three coaches. The engineer was unaware of the blaze until he rounded a corner some miles afterwards. Only the steel chassis of the cars remained when the train was halted.

FEB. 13, 1937, ANTUNG, MANCHUKUO. A fire in a "built to burn" theatre, jammed to over capacity with 1500 persons, broke out when a candle tipped over in an actor's dressing room. Locked and otherwise inadequate exits were partly responsible in the loss of nearly 700 lives. Hundreds of bodies were found piled on the stairs.

MARCH 15, 1937, MANILA, P. I. An explosion of powder in a fireworks factory started a fire that spread rapidly out of control through the plant. Nineteen women were killed either in the explosion, the fire, or the jam which occurred at the only exit from the factory. Rescue efforts were hampered by the continued explosions in the demolished building.

MARCH 17, 1937, KAMIKANO, JAPAN. Fifty-eight men were burned or gassed to death in a coal mine fire. Many of them were firemen fighting the fire.

Typical Loss of Life Fires.

Boat and Ship Fires.

JAN. 24, 1937, HUNTINGTON, W. VA. A boat rescuing a family from a flooded home caught fire when a woman tossed a lighted match into gasoline floating on the water. Three persons were burned to death. Four others were seriously injured. (See account on page 334.) (H-41507.)

FEB. 13, 1937, OKEECHOBEE, FLA. A fifty-gallon tank of gasoline aboard a houseboat exploded, and the fire trapped and burned to death three men. (H-41508.)

Children Alone in House.

JAN. 13, 1937, WAYNE, WIS. A four-year-old boy left alone in a house with his baby brother pushed the baby carriage too near the stove, and a blanket ignited. The baby was burned to death. A neighbor saved the house by quickly rolling the carriage outside. (L-3876.)

MARCH 3, 1937, PORT WASHINGTON, L. I. A mother put a pot of jelly on the stove to cook and left three children alone in the house. The children either upset the jelly, or it boiled over, setting fire to the house. The three children were burned to death. (L-3875.)

Clothing Ignited.

DEC. 29, 1936, SELMA, ALA. At a country club costume party a woman dressed in cotton flannel trimmed with cotton batting ignited her clothes as she lit a cigarette. The fire spread over the similar costumes of other women, and six of them were burned to death. (H-41509.)

JAN. 3, 1937, NEW YORK, N. Y. A man was burned to death when he fell asleep in a chair while smoking. His clothing was ignited by the cigarette. (L-3874.)

MARCH 22, 1937, NEW YORK, N. Y. A woman was burning a pile of

leaves when a gust of wind scattered sparks that ignited her clothing. She was burned to death before she could be helped. (L-3873.)

Propane Gas Explosion.

DEC. 31, 1936, CHESTER, PA. A gas chamber located between shipways at a shipbuilding plant exploded when a match struck to light a cigarette ignited some of the leaking propane gas. Several workmen were thrown through the air and injured. Two of them were killed. (H-41510.)

Blasting Powder Explosion.

JAN. 23, 1937, FAIRVIEW, ILL. A keg of blasting powder was brought into a miner's home to be dried out. It was set near the stove. The family were assembled at dinner when the keg exploded and set fire to the house. Six were killed, and the five others injured. (L-3872.)

Gasoline Explosions.

FEB. 1, 1937, DANNEBROG, NEB. A can of gasoline was set on the stove to warm in a rural dwelling. The resulting explosion killed four children and seriously injured their mother and father. (L-3871.)

FEB. 15, 1937, BUCKEYE, ARIZ. Transient cotton pickers stored a 55-gallon gasoline drum in the tent they used as a dwelling. While one man was drawing gasoline to fill his car, another threw some of the liquid on the fire. The vapors ignited, and in a moment the open drum had spread flaming gasoline through the tent. Two children who were sleeping, and the man who had thrown the gasoline, were fatally burned. (L-3870.)

FEB. 17, 1937, PHOENIX, ARIZ. A man using a gasoline blow torch was fatally burned when the pressure tank exploded. The gasoline was immediately ignited by a near-by stove. (H-41511.)

MARCH, 19, 1937, BINGHAM, MAINE. Lighting a fire in a hunting camp, a man mistook a can of gasoline for kerosene. He was killed in the explosion, and another man was seriously injured. (L-3869.)

Flue Cleaning Compound Explosion.

JAN. 14, 1937, DANBURY, CONN. A man was using a flue cleaning compound in a furnace firebox. The flammable compound was ignited in an unknown manner, and the man was killed in the explosion. (H-41512.)

Lacquer Thinner Explosion.

JAN. 28, 1937, DORCHESTER, MASS. Boys built a bonfire in a dump to burn wood from reclaimable metal. One of them threw a nearly empty can of lacquer thinner on the fire. The can exploded, spraying the boys with burning liquid. One was fatally burned, another seriously injured. (L-3868.)

Oil Pipe Lines.

JAN. 13, 1937, PRYOR, OKLA. Workmen were using an acetylene torch to repair a leaking crude oil pipe line. The vapors ignited and two workers and

four women spectators were instantly burned to death. The car in which the women were sitting was reduced to molten metal. (H-41513.)

JAN. 18, 1937, RUSSEL, KAN. A repair man was welding a pipe line leading from a treating tank to storage tanks in an oil field. An explosion occurred which involved the treating tank and killed three men. (H-41514.)

Oil Burner Tank.

FEB. 8, 1937, CHICAGO, ILL. A woman measured the oil in an inside storage tank for an oil burner in the basement of her home. She read the stick with a match while the cap was still off the tank. In the explosion she was killed and one wall of her house was blown out. (L-3867.)

Gasoline Filling Station.

DEC. 24, 1936, BENTON, ARK. An automobile crashed into fuel pumps at a gasoline filling station and in the resulting fire, a woman bystander and the four occupants of the car were fatally burned. (H-41506.)

Gasoline Tank Vessel.

JAN. 1, 1937, CHARLEVOIX, MICH. A tanker was attempting salvage of a 900,000-gallon cargo of gasoline aboard a wrecked gasoline boat. An explosion and fire occurred on the salvage boat that killed the five men aboard her. (H-41515.)

Pyroxylin Comb Fire.

JAN. 3, 1937, CINCINNATI, OHIO. A woman was fatally burned when a pyroxylin comb in her hair was ignited by sparks from an electric dryer. Her sister was seriously injured. (L-3866.)

Prison Fires.

DEC. 16, 1936, BISHOP, CAL. A man locked up overnight in the city jail was suffocated when his bedding caught fire, probably from a cigarette. (H-41516.)

FEB. 26, 1937, FRIES, VA. A man was held in the town lockup overnight. His bedding caught fire, probably from a cigarette, and he was suffocated by the smoke. The lockup had no night keeper. (H-41517.)

Smoking in Bed.

MARCH 7, 1937, NEWTON, MASS. A man fell asleep while smoking in bed, and set a fire that burned him fatally, and spread through his three-room apartment. (L-3865.)

Fire Apparatus Accident.

MARCH 5, 1937, BOSTON, MASS. A fire truck returning from a fire got out of control and crashed into a group of children. One of them died of a fractured skull. (L-3864.)

Shock Due to Fire.

MARCH 22, 1937, LEESBURG, VA. A man saw that his stable was on fire and fell dead of a heart attack as he hurried to his house for help. (L-3863.)

Annual Sprinkler Tables—1937.

The annual sprinkler tabulation is published this year for the forty-first consecutive year. The tables which follow show the actual fire experience with automatic sprinkler equipments in seventy-three thousand seven hundred fires. This is not intended as a complete statistical report of fires in sprinklered properties; it includes only those fires reported to the N.F.P.A. Department of Fire Record in sufficient detail to give the data necessary for the tables. While the fires included in this tabulation are probably only about half of the total number of fires occurring in buildings under sprinkler protection, with a total of 73,700 fires in the record and current reports being received at an average rate of approximately twenty-five hundred annually, there can be no doubt that this summary as a whole is completely representative, except perhaps in some occupancies where only a small number of fires are reported.

The total number of sprinklered fire reports received during the past year was 2400, including 413 fires in which the sprinklers were not a factor. Fires that occurred in unsprinklered portions of buildings and did not extend to the sprinklered portions, or fires that occurred in sprinklered portions and were discovered and extinguished by other means before there was sufficient heat to open sprinklers are included in the latter figure. The total number of fires since 1897 in sprinklered properties where sprinklers were not a factor is 13,918.

The classifications "extinguished fire" and "held fire in check" appearing in the several tables may both be considered as satisfactory performance. The distinction between these two classifications is necessarily more or less arbitrary, depending upon the judgment of the original inspector. The great majority of the fires in the "held in check" columns are instances where hose streams or other equipment were used to extinguish fire in spaces which water from the sprinklers did not reach because of minor obstructions to distribution or unsprinklered portions, but where sprinklers functioned satisfactorily in preventing the spread of fire.

When reviewing the detailed tabulation of unsatisfactory sprinkler performance it should be noted that these fires represent a small percentage of the total number included in the record and that they are compiled not with the thought of emphasizing the relatively few cases where sprinkler operation is unsatisfactory, but pointing the way toward better performance by indicating those factors which should receive attention.

The annual sprinkler tables are designed to show to what degree fires have been automatically controlled in buildings equipped with automatic

sprinklers. The term "Unsatisfactory" does not necessarily imply mechanical failure of the sprinkler equipment. Neither does it indicate that there was a large loss in a sprinklered building. "Unsatisfactory" sprinkler control means that for various reasons the sprinkler equipment did not automatically extinguish the fire or hold it in check. Reasons for "Unsatisfactory" sprinkler control are shown in Section I, and in Table No. 5 of Section II, of the following tables. In many of the fires where automatic sprinkler control was "Unsatisfactory" the loss was small, due to prompt extinguishment by other fire fighting equipment.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires.

	1936-1937		1897-1937	
	No. of Fires	Per Cent	No. of Fires	Per Cent
Water shut off	28	44.5	774	33.0
Generally defective equipment	4	6.3	210	9.0
Unsprinklered portions	4	6.3	191	8.2
Defective water supply or supplies	4	6.3	205	8.7
Sprinkler system crippled due to freezing	..	..	70	3.0
Slow operation of dry system or defective valve	2	3.2	74	3.2
Slow or defective operation of high test heads	..	..	27	1.1
Faulty building construction, concealed spaces, vertical openings, etc.	2	3.2	114	4.9
Obstruction to distribution	4	6.3	140	6.0
Hazard of occupancy too severe for average sprinkler equipment	5	7.9	134	5.7
Explosion crippled sprinkler system	2	3.2	114	4.9
Exposure or conflagration	1	1.6	90	3.8
Plugged heads and clogged piping	6	9.6	70	3.0
Miscellaneous	1	1.6	129	5.5
Total	63	100.0	2342	100.0

Fires in Which Failure Was Due to Water Shut Off Sprinklers.

Water shut off:	1936-1937 No. of Fires	1897-1937 No. of Fires
Unknown reason, neglect or carelessness	12	230
Before fire was out, or fire rekindled	9	145
Accidents or repairs	2	114
To prevent freezing	3	175
Probably incendiary	..	36
Leaky dry system	2	21
Defective gate valve	..	9
Miscellaneous	..	44
Total	28	774

SECTION II.

Table No. 1 — Effect of Sprinklers.

	1936-1937 No. of Fires	%	1897-1937 No. of Fires	%
Practically or entirely extinguished....	1415	71.2	41882	70.1
Held fire in check.....	509	25.6	15558	26.0
Total Satisfactory.....	1924	96.8	57440	96.1
Unsatisfactory	63	3.2	2342	3.9
Total	1987	100.0	59782	100.0

Table No. 2 — Number of Sprinklers Operating—Cumulative.

No. of Fires, 1897-1937.

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	18071	38.9	2055	20.4	766	20892	35.0
2 or less.....	26703	57.5	3499	34.8	1120	31322	52.4
3 or less.....	31280	67.6	4380	43.6	1320	36980	61.9
4 or less.....	34400	74.3	5106	50.8	1481	40987	68.6
5 or less.....	36272	78.3	5583	55.5	1583	43438	72.7
6 or less.....	37774	81.5	6014	59.8	1672	45460	76.1
7 or less.....	38828	83.8	6347	63.1	1720	46895	78.5
8 or less.....	39804	85.9	6630	65.9	1781	48215	80.7
9 or less.....	40454	87.3	6866	68.2	1821	49141	82.2
10 or less.....	41030	88.5	7056	70.1	1869	49955	83.6
11 or less.....	41476	89.5	7217	71.7	1891	50584	84.6
12 or less.....	41957	90.5	7420	73.7	1940	51317	85.8
13 or less.....	42238	91.1	7568	75.2	1959	51765	86.5
14 or less.....	42558	91.8	7715	76.7	1985	52258	87.3
15 or less.....	42821	92.4	7840	77.9	2007	52668	88.0
20 or less.....	43739	94.4	8261	82.1	2085	54085	90.4
25 or less.....	44281	95.6	8563	85.1	2124	54968	91.9
30 or less.....	44651	96.4	8767	87.1	2153	55571	92.9
35 or less.....	44877	96.9	8914	88.6	2176	55967	93.6
40 or less.....	45080	97.3	9032	89.8	2197	56309	94.2
50 or less.....	45329	97.8	9199	91.5	2230	56758	94.9
75 or less.....	45665	98.5	9416	93.7	2264	57345	95.9
100 or less.....	45817	98.8	9530	94.8	2275	57622	96.4
Over 100.....	467		387		53	907	
No data	114		105		1002	1221	
Open head systems	0		32		0	32	
Total.....	46398		10054		3330	59782	

Table No. 3 — Number of Sprinklers Operating.

No. of Fires, 1936-1937.

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	659	45.0	93	25.4	38	790	39.8
2	277	18.8	66	18.0	21	364	18.3
3	132	9.1	29	7.9	8	169	8.5
4	88	6.0	26	7.1	6	120	6.0
5	51	3.5	24	6.6	6	81	4.1
6	40	2.7	14	3.8	7	61	3.1
7	31	2.1	10	2.7	2	43	2.2
8	22	1.5	12	3.3	6	40	2.0
9	19	1.3	12	3.3	4	35	1.8
10	10	.7	3	.8	2	15	.7
11	16	1.1	5	1.4	1	22	1.1
12	13	.9	4	1.1	4	21	1.1
13	9	.6	3	.8	0	12	.6
14	4	.3	6	1.6	2	12	.6
15	5	.3	4	1.1	3	12	.6
16-20	21	1.4	16	4.4	4	41	2.1
21-25	18	1.2	3	.8	5	26	1.3
26-30	11	.8	5	1.4	4	20	1.0
31-35	6	.4	6	1.6	2	14	.7
36-40	6	.4	2	.6	1	9	.4
41-50	6	.4	7	1.9	3	16	.8
51-75	6	.4	4	1.1	3	13	.6
76-100	1	.1	3	.8	0	4	.2
Over 100	15	1.0	6	1.6	6	27	1.4
No data	0	..	2	.6	17	19	.9
Open head system	..	..	1	.3	..	1	.1
Total	1466	100.0	366		155	1987	

No. of Fires, 1897-1937.

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	18071	38.9	2055	20.4	766	20892	35.0
2	8632	18.6	1444	14.4	354	10430	17.4
3	4577	10.1	881	8.8	200	5658	9.5
4	3120	6.7	726	7.2	161	4007	6.7
5	1872	4.0	477	4.7	102	2451	4.1
6	1502	3.2	431	4.3	89	2022	3.4
7	1054	2.3	333	3.3	48	1435	2.4
8	976	2.1	283	2.8	61	1320	2.2
9	650	1.4	236	2.3	40	926	1.5
10	576	1.2	190	1.9	48	814	1.4
11	446	1.0	161	1.6	22	629	1.0
12	481	1.0	203	2.0	49	733	1.2
13	281	.6	148	1.5	19	448	.7
14	320	.7	147	1.5	26	493	.8
15	263	.6	125	1.2	22	410	.7
16-20	918	2.0	421	4.2	78	1417	2.4
21-25	542	1.2	302	3.0	39	883	1.5
26-30	370	.8	204	2.0	29	603	1.0
31-35	226	.5	147	1.5	23	396	.7
36-40	203	.4	118	1.2	21	342	.6
41-50	249	.5	167	1.7	33	449	.7
51-75	336	.7	217	2.2	34	587	1.0
76-100	152	.3	114	1.1	11	277	.5
Over 100	467	1.0	387	3.9	53	907	1.5
No data	114	.2	105	1.0	1002	1221	2.0
Open head systems	0	..	32	.3	0	32	.1
Total	46398		10054		3330	59782	

Table No. 4 — Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Abrasive Works	31	73.8	9	21.4	40	95.2	2	4.8	42
Agricultural Implements	88	62.5	48	34.0	136	96.5	5	3.5	141
Airplane Factories	8	50.0	8	50.0	16	100.0	0	..	16
Airports and Hangars	3	42.9	4	57.1	7	100.0	0	..	7
Alcohol Distilleries	1	16.7	4	66.7	5	83.4	1	16.6	6
Aluminum Works	7	53.8	4	30.8	11	84.6	2	15.4	13
Amusement Places	36	78.2	5	10.9	41	89.1	5	10.9	46
Apartment Houses	188	86.6	29	13.4	217	100.0	0	..	217
Artificial Leather Mfg.	38	52.0	32	43.9	70	95.9	3	4.1	73
Asbestos Works	30	56.6	20	37.7	50	94.3	3	5.7	53
Automobile Mfg.	374	66.7	165	29.4	539	96.1	22	3.9	561
Automobile Body Mfg.	166	59.7	86	30.9	252	90.6	26	9.4	278
Automobile Paint Shops	13	65.0	7	35.0	20	100.0	0	..	20
Auto Sales and Service	57	70.4	18	22.2	75	92.6	6	7.4	81
Bag Factories	56	60.9	30	32.6	86	93.5	6	6.5	92
Bakeries	230	77.7	58	19.6	288	97.3	8	2.7	296
Basket Factories	15	83.3	2	11.1	17	94.4	1	5.6	18
Battery Mfg.	45	67.1	19	28.4	64	95.5	3	4.5	67
Bolt, Nut, and Screw Works	27	60.0	15	33.3	42	93.3	3	6.7	45
Bottle Cap and Seals Mfg.	56	57.7	41	42.3	97	100.0	0	..	97
Bottling Works	12	80.0	2	13.3	14	93.3	1	6.7	15
Braid Mills	72	75.8	21	22.1	93	97.9	2	2.1	95
Brass and Copper Works	91	73.4	30	24.2	121	97.6	3	2.4	124
Breweries	5	55.5	4	44.5	9	100.0	0	..	9
Brick and Tile Works	1	100.0	0	..	1	100.0	0	..	1
Broom Factories	27	71.1	8	21.0	35	92.1	3	7.9	38
Brush Factories	37	69.8	15	28.3	52	98.1	1	1.9	53
Buildings under Construction	5	50.0	3	30.0	8	80.0	2	20.0	10
Button Factories	86	83.5	15	14.6	101	98.1	2	1.9	103
Candle Factories	10	58.8	7	41.2	17	100.0	0	..	17
Candy Factories	280	73.1	92	24.0	372	97.1	11	2.9	383
Canneries	21	65.6	8	25.0	29	90.6	3	9.4	32
Canvas and Cotton Belting	9	69.2	4	30.8	13	100.0	0	..	13
Carbon Works	12	80.0	3	20.0	15	100.0	0	..	15
Car Houses	48	46.6	46	44.7	94	91.3	9	8.7	103
Car Works	83	61.1	49	36.0	132	97.1	4	2.9	136
Carpet and Rug Mills	232	64.8	112	31.3	344	96.1	14	3.9	358
Casket Mfg.	88	74.6	25	21.2	113	95.8	5	4.2	118
Cement and Plaster Mills	16	72.8	3	13.6	19	86.4	3	13.6	22
Cereal Mills	46	64.7	17	24.0	63	88.7	8	11.3	71
Chemical and White Lead Works	252	62.5	125	31.0	377	93.5	26	6.5	403
Churches	1	100.0	0	..	1	100.0	0	..	1
Clock and Watch Mfg.	21	80.8	5	19.2	26	100.0	0	..	26
Clothing Mfg.	2522	86.2	382	13.0	2904	99.2	24	.8	2928
Clubs—City	33	82.5	6	15.0	39	97.5	1	2.5	40
Clubs—Country	22	71.0	9	29.0	31	100.0	0	..	31
Coal and Wood Yards	3	27.3	7	63.6	10	90.9	1	9.1	11
Cocoanut Mills	6	75.0	2	25.0	8	100.0	0	..	8
Coffee and Spice Plants	110	71.9	40	26.1	150	98.0	3	2.0	153
Cold Storage Plants	19	70.3	8	29.7	27	100.0	0	..	27
Cooperage Plants	67	60.4	32	28.8	99	89.2	12	10.8	111
Cordage Works	272	65.5	128	30.8	400	96.3	16	3.7	416
Cork Plants	35	54.6	23	36.0	58	90.6	6	9.4	64
Cotton Gins	14	60.9	7	30.4	21	91.3	2	8.7	23
Cotton Mills	6912	66.3	3401	32.6	10313	98.9	118	1.1	10431
Cotton Seed Oil Mills	48	47.0	34	33.4	82	80.4	20	19.6	102
Cotton Warehouses	281	50.6	224	40.4	505	91.0	50	9.0	555

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Cutlery Mfg.	31	60.8	17	33.3	48	94.1	3	5.9	51
Dairies and Creameries	11	73.3	4	26.7	15	100.0	0	..	15
Department Stores	903	80.2	197	17.5	1100	97.7	25	2.3	1125
Distilleries	17	60.7	6	21.4	23	82.1	5	17.9	28
Doll Factories	98	66.7	49	33.3	147	100.0	0	..	147
Drug Mfg. and Warehouse	291	79.9	65	17.9	356	97.8	8	2.2	364
Dry Cleaning Establishments	33	68.7	14	29.2	47	97.9	1	2.1	48
Dry Goods Stores	429	86.3	62	12.5	491	98.8	6	1.2	497
Dwellings	2	66.7	0	..	2	66.7	1	33.3	3
Dyeing, Bleaching, Finishing	355	60.9	209	35.8	564	96.7	19	3.3	583
Electrical Appliance Mfg.	609	73.7	203	24.6	812	98.3	14	1.7	826
Electric Power and Light	10	43.5	9	39.1	19	82.6	4	17.4	23
Excelsior Factories	38	67.9	13	23.2	51	91.1	5	8.9	56
Fertilizer Plants	33	66.0	13	26.0	46	92.0	4	8.0	50
Fibre Products	21	52.5	14	35.0	35	87.5	5	12.5	40
Fireworks Plants	1	16.7	3	50.0	4	66.7	2	33.3	6
Flax and Linen Mills	54	58.7	37	40.2	91	98.9	1	1.1	92
Flour and Grist Mills	107	55.7	53	27.6	160	83.3	32	16.7	192
Forge and Smithy	31	70.4	11	25.0	42	95.4	2	4.6	44
Foundries	273	60.9	154	34.4	427	95.3	21	4.7	448
Fruit Packing	12	85.7	2	14.3	14	100.0	0	..	14
Fur Works	264	92.6	16	5.6	280	98.2	5	1.8	285
Furniture Factories	1182	68.7	421	24.4	1603	93.1	119	6.9	1722
Furniture Stores	160	80.1	32	16.0	192	96.1	8	3.9	207
Garages	709	72.0	256	26.0	965	98.0	20	2.0	985
Garbage Reduction Plants	3	50.0	2	33.3	5	83.3	1	16.7	6
Gas Works	4	44.4	4	44.4	8	88.8	1	11.2	9
General Stores	1	50.0	1	50.0	2	100.0	0	..	2
Glass Factories	117	60.9	57	29.7	174	90.6	18	9.4	192
Glove Factories	23	67.7	10	29.4	33	97.1	1	2.9	34
Glue Factories	10	45.5	9	40.8	19	86.3	3	13.7	22
Grain Elevators	45	42.8	33	31.4	78	74.2	27	25.8	105
Groceries	243	78.9	54	17.5	297	96.4	11	3.6	308
Gum Mfg.	11	84.6	2	15.4	13	100.0	0	..	13
Hair Works	31	81.6	7	18.4	38	100.0	0	..	38
Hardware Stores	140	82.3	27	15.9	167	98.2	3	1.8	170
Hat Factories	511	80.9	100	15.8	611	96.7	21	3.3	632
Hospitals	38	80.9	9	19.1	47	100.0	0	..	47
Hotels—Year Round	141	83.4	23	13.6	164	97.0	5	3.0	169
Hotels—Seasonal	21	70.0	8	26.7	29	96.7	1	3.3	30
Ice Cream Mfg.	7	58.3	5	41.7	12	100.0	0	..	12
Ice Houses	0	..	2	66.7	2	66.7	1	33.3	3
Ice Manufacturing	2	66.7	1	33.3	3	100.0	0	..	3
Idle and Vacant Property	52	54.2	21	21.9	73	76.1	23	23.9	96
Incandescent Lamp Works	27	67.5	13	32.5	40	100.0	0	..	40
Institutions	20	95.3	1	4.7	21	100.0	0	..	21
Insulated Wire Works	71	67.0	33	31.1	104	98.1	2	1.9	106
Jewelry Factories	223	83.2	37	13.8	260	97.0	8	3.0	268
Junk Shops	35	64.8	14	25.9	49	90.7	5	9.3	54
Knitting Mills—Cop Yarn	75	68.8	27	24.8	102	93.6	7	6.4	109
Knitting Mills—Full Process	718	69.4	283	27.4	1001	96.8	33	3.2	1034
Lamp Shade Factories	57	90.5	5	7.9	62	98.4	1	1.6	63
Laundries	212	74.2	65	22.7	277	96.9	9	3.1	286
Leather Working	281	83.4	51	15.1	332	98.5	5	1.5	337
Linoleum Works	43	30.7	77	55.0	120	85.7	20	14.3	140
Linseed Oil Works	29	52.7	17	30.9	46	83.6	9	16.4	55
Lumber Yards	9	56.2	6	37.5	15	93.7	1	6.3	16
Macaroni Factories	14	60.9	7	30.4	21	91.3	2	8.7	23
Machine Shops and Works	535	72.7	168	22.8	703	95.5	33	4.5	736

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Mail Order Houses	69	87.3	10	12.7	79	100.0	0	..	79
Match Factories	81	75.7	21	19.6	102	95.3	5	4.7	107
Mattress Factories	731	71.9	270	26.5	1001	98.4	17	1.6	1018
Mercantile (Miscellaneous)	1195	83.0	211	14.6	1406	97.6	35	2.4	1441
Metal Reduction Plants	11	61.2	7	38.8	18	100.0	0	..	18
Metal Workers†	1430	64.9	690	31.4	2120	96.3	81	3.7	2201
Mining Property	7	70.0	2	20.0	9	90.0	1	10.0	10
Mirror Mfg.	22	88.0	2	8.0	24	96.0	1	4.0	25
Miscellaneous	486	75.3	141	21.8	627	97.1	19	2.9	646
Motion Picture Exchanges	58	78.4	14	18.9	72	97.3	2	2.7	74
Motion Picture Studios	56	77.8	15	20.8	71	98.6	1	1.4	72
Motion Picture Theatres	108	77.7	25	18.0	133	95.7	6	4.3	139
Multiple Occupancy	215	78.8	41	15.0	256	93.8	17	6.2	273
Munitions	25	42.3	24	40.7	49	83.0	10	17.0	59
Musical Instrument Factories	171	70.7	64	26.4	235	97.1	7	2.9	242
Office Buildings	138	89.6	16	10.4	154	100.0	0	..	154
Oil Cloth Works	37	50.0	30	40.5	67	90.5	7	9.5	74
Oil Clothing Factories	26	86.7	3	10.0	29	96.7	1	3.3	30
Oil Distributing Station	2	40.0	3	60.0	5	100.0	0	..	5
Oil Refineries—Animal	5	55.6	3	33.3	8	88.9	1	11.1	9
Oil Refineries—Mineral	7	58.4	4	33.3	11	91.7	1	8.3	12
Oil Refineries—Vegetable	12	46.2	12	46.2	24	92.4	2	7.6	26
Optical Works	25	65.8	13	34.2	38	100.0	0	..	38
Packing Houses	217	68.3	87	27.4	304	95.7	14	4.3	318
Paint and Varnish Works	346	66.2	157	30.0	503	96.2	20	3.8	523
Paper Coating Mills	48	65.8	19	26.0	67	91.8	6	8.2	73
Paper Mills	759	52.7	555	38.6	1314	91.3	125	8.7	1439
Paper Working	470	75.1	143	22.8	613	97.9	13	2.1	626
Peanut Roasting Plants	7	53.8	3	23.1	10	76.9	3	23.1	13
Pencil Factories	22	71.0	8	25.8	30	96.8	1	3.2	31
Phonograph Works	34	66.7	15	29.4	49	96.1	2	3.9	51
Photo Camera and Film Mfg.	27	71.1	11	28.9	38	100.0	0	..	38
Photo Engraving and Studios	69	88.4	8	10.3	77	98.7	1	1.3	78
Picture Frame Mfg.	68	68.0	26	26.0	94	94.0	6	6.0	100
Piers and Wharves	28	53.9	21	40.3	49	94.2	3	5.8	52
Plumbers Supplies	48	75.0	13	20.3	61	95.3	3	4.7	64
Potteries	62	64.6	26	27.1	88	91.7	8	8.3	96
Printing and Lithographing	1359	83.1	249	15.2	1608	98.3	28	1.7	1636
Prisons	5	45.4	4	36.4	9	81.8	2	18.2	11
Public Buildings	14	73.7	3	15.8	17	89.5	2	10.5	19
Pulp Mills	54	39.5	56	40.8	110	80.3	27	19.7	137
Pyroxylin Plastic Mfg. Fabrication	296	66.3	106	23.8	402	90.1	44	9.9	446
Radios and Accessories	76	82.6	13	14.1	89	96.7	3	3.3	92
Railroad—Misc. Property	5	31.2	10	62.5	15	93.7	1	6.3	16
Railroad—Repair Shops	4	40.0	6	60.0	10	100.0	0	..	10
Rayon Mills	31	79.5	6	15.4	37	94.9	2	5.1	39
Restaurants	247	76.3	74	22.8	321	99.1	3	.9	324
Rice Mills	2	25.0	2	25.0	4	50.0	4	50.0	8
Rolling, Wire and Tube Mills	96	63.6	49	32.4	145	96.0	6	4.0	151
Roofing Works	53	36.8	80	55.5	133	92.3	11	7.7	144
Rooming and Lodging Houses	10	90.9	0	.0	10	90.9	1	9.1	11
Rubber Cloth Factories	112	68.7	47	28.8	159	97.5	4	2.5	163
Rubber Reclaiming Works	23	53.5	10	23.2	33	76.7	10	23.3	43
Rubber Mills	331	58.0	212	37.1	543	95.1	28	4.9	571
Salt Works	2	50.0	2	50.0	4	100.0	0	..	4
Saw and Planing Mills	128	41.9	97	31.6	225	73.5	81	26.5	306
Schools—Colleges and Universities	22	84.7	4	15.3	26	100.0	0	..	26
Schools—Private	7	70.0	2	20.0	9	90.0	1	10.0	10
Schools—Public	9	56.2	4	25.0	13	81.2	3	18.8	16

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Schools—Trade and Industrial	15	79.0	2	10.5	17	89.5	2	10.5	19
Shipyards	20	54.1	14	37.8	34	91.9	3	8.1	37
Shoddy Mills	294	64.3	137	30.0	431	94.3	26	5.7	457
Shoe Factories	1096	75.7	301	20.8	1397	96.5	50	3.5	1447
Shoe Mfg. Accessories	115	71.0	40	24.7	155	95.7	7	4.3	162
Shoe Stores	94	87.8	13	12.2	107	100.0	0	..	107
Silk Mills	214	82.6	37	14.3	251	96.9	8	3.1	259
Smelting and Refining	8	61.5	4	30.8	12	92.3	1	7.7	13
Soap Manufacturing	60	71.4	21	25.0	81	96.4	3	3.6	84
Stables	25	75.8	8	24.2	33	100.0	0	..	33
Stamping and Sheet Metal Works	206	63.5	100	30.9	306	94.4	18	5.6	324
Starch and Glucose	17	54.9	6	19.3	23	74.2	8	25.8	31
Stone Working	4	100.0	0	..	4	100.0	0	..	4
Sugar Refineries	44	51.2	38	44.2	82	95.4	4	4.6	86
Tannery, Class A**	27	45.8	27	45.8	54	91.6	5	8.4	59
Tannery, Class B**	152	58.7	86	33.2	238	91.9	21	8.1	259
Tannery, Class C**	19	43.2	20	45.4	39	88.6	5	11.4	44
Tannery, Class D**	29	69.0	11	26.2	40	95.2	2	4.8	42
Telephone Exchanges	4	100.0	0	..	4	100.0	0	..	4
Tenant Manufacturing	2135	79.1	467	17.3	2602	96.4	98	3.6	2700
Theatres	108	77.1	25	17.9	133	95.0	7	5.0	140
Tobacco Factories	100	75.8	28	21.2	128	97.0	4	3.0	132
Tobacco Warehouses	9	64.3	4	28.6	13	92.9	1	7.1	14
Trunk Factories	49	73.2	11	16.4	60	89.6	7	10.4	67
Umbrella Mfg.	23	82.1	4	14.3	27	96.4	1	3.6	28
Vinegar Works	1	100.0	0	..	1	100.0	0	..	1
Wall Paper Factories	31	72.1	8	18.6	39	90.7	4	9.3	43
Warehouses	571	74.6	159	20.7	730	95.3	36	4.7	766
Waste and Batting Mills	433	61.1	244	34.4	677	95.5	32	4.5	709
Waste Paper and Rag Shops	323	65.5	147	29.8	470	95.3	23	4.7	493
Water Works	1	33.3	2	66.7	3	100.0	0	..	3
Weaving Mills	219	69.3	90	28.5	309	97.8	7	2.2	316
Window Shade Factories	19	76.0	4	16.0	23	92.0	2	8.0	25
Woodworker, Class A*	226	54.8	131	31.9	357	86.7	55	13.3	412
Woodworker, Class B*	224	54.2	151	36.6	375	90.8	38	9.2	413
Woodworker, Class C*	232	62.4	119	32.0	351	94.4	21	5.6	372
Woodworker, Class D*	150	56.8	89	33.7	239	90.5	25	9.5	264
Woodworker, Class E*	212	64.4	99	30.1	311	94.5	18	5.5	329
Woodworker, Class F*	49	59.0	28	33.8	77	92.8	6	7.2	83
Woodworker, Class G*	3	23.1	9	69.2	12	92.3	1	7.7	13
Woodworker, Class H*	103	78.6	26	19.9	129	98.5	2	1.5	131
Woolen Mills	1328	70.5	473	25.1	1801	95.6	83	4.4	1884
Wool Scouring Plants	44	68.7	17	26.6	61	95.3	3	4.7	64
Wool Storehouses	35	68.6	13	25.5	48	94.1	3	5.9	51
Worsted Mills	112	61.2	56	30.6	168	91.8	15	8.2	183
Total	41882		15558		57440		2342		59782

*The Woodworkers are classified as follows:

Class A. Interior Woodwork, builders' supplies (including veneer works). Class B. Box factories (including cigar boxes). Class C. Miscellaneous Woodworkers. Steam power tenant Woodworkers. Woodworkers where there is a lack of detailed information as to class. Class D. Sash, Door and Blind Factories. Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc.). Class F. Pails and Woodenware (plates, wooden bowls, tubs, etc.). Class G. Wood Flour Mills. Class H. Wood Heel and Shoe Last Factories.

†Other Metal Working Occupancies are included under Agricultural Implements; Automobile and Bicycle Factories; Bolt, Nut and Screw Works; Electrical Appliances; Forge and Smithy; Foundries; Machine Works; Rolling, Wire and Tube Works; and Stamping and Sheet Metal Works.

**See detailed classification of Tanneries as given in note under Table No. 5.

Table No. 5 — Classification of Unsatisfactory Sprinkler Fires by Occupancy.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged heads and clogged piping.	Miscellaneous.	Total.
Abrasive Works	..	1	..	..	..	..	..	..	..	..	..	..	1	2
Agricultural Implements	3	1	..	..	..	..	..	1	..	..	..	..	..	5
Alcohol Distilleries	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Aluminum Works	..	..	..	..	..	..	..	..	1	1	..	..	..	2
Amusement Places	3	..	..	..	..	..	1	..	..	..	..	1	..	5
Artificial Leather Mfg.	..	..	..	..	..	..	1	..	..	2	..	..	..	3
Asbestos Works	..	..	2	..	..	..	..	..	..	1	..	..	..	3
Automobile Mfg.	9	2	2	..	1	..	..	4	..	2	1	1	..	22
Auto Body Mfg.	4	6	3	..	2	..	1	3	1	1	3	1	1	26
Auto Sales and Service	3	1	..	1	..	..	..	..	..	1	..	..	..	6
Bag Factories	1	..	..	..	..	2	..	1	..	..	..	2	..	6
Bakeries	4	1	..	..	..	..	1	..	..	..	..	..	2	8
Basket Factories	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Battery Mfg.	2	..	..	..	..	..	..	..	..	..	..	1	..	3
Bolt, Nut, and Screw Works	1	2	..	..	..	..	..	..	..	..	..	..	..	3
Bottling Works	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Braid Mills	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Brass and Copper Works	1	1	..	..	..	..	..	..	..	..	..	..	1	3
Broom Factories	3	..	..	..	..	..	..	..	..	..	..	..	..	3
Brush Factories	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Building Construction	1	..	..	..	..	..	1	..	..	..	..	..	..	2
Button Factories	..	..	..	2	..	..	..	..	..	..	..	..	..	2
Candy Factories	4	..	..	1	1	..	1	..	..	..	1	2	1	11
Canneries	1	..	..	..	1	..	..	..	..	..	1	..	..	3
Car Houses	2	3	1	..	1	..	..	1	..	..	..	1	..	9
Car Works	2	..	..	..	..	..	1	1	..	..	..	..	..	4
Carpet and Rug Mills	4	3	4	1	..	..	..	2	..	..	..	..	..	14
Casket Mfg.	2	..	..	1	1	..	1	..	..	..	..	..	..	5
Cement and Plaster Mills	1	1	..	..	1	..	..	..	..	..	..	..	..	3
Cereal Mills	..	2	1	..	..	..	..	1	..	4	..	..	..	8
Chemical & White Lead Wks.	3	5	..	..	..	..	..	1	6	9	1	..	1	26
Clothing Mfg.	9	2	1	1	..	..	3	2	..	..	2	2	2	24
Clubs—City	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Coal and Wood Yards	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Coffee and Spice Plants	2	..	..	..	..	..	..	..	..	1	..	..	..	3
Cooperage Plants	1	4	..	..	..	1	..	4	..	..	2	..	..	12
Cordage Works	5	5	1	1	..	..	..	3	..	..	..	..	1	16
Cork Plants	1	..	1	..	..	..	..	..	2	1	..	..	1	6
Cotton Gins	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Cotton Mills	43	27	11	2	2	1	5	3	3	1	..	6	14	118
Cotton Seed Oil Mills	4	7	4	..	..	..	..	..	2	..	..	1	2	20
Cotton Warehouses	17	4	8	..	2	..	1	8	3	..	..	4	3	50
Cutlery Mfg.	1	1	1	..	..	..	..	..	..	..	..	..	..	3
Department Stores	12	4	1	..	2	..	2	1	..	..	2	..	1	25
Distilleries	2	..	..	..	..	..	..	..	..	1	1	..	1	5
Drug Mfg. and Warehouses	3	..	..	..	1	..	..	..	..	..	3	..	1	8
Dry Cleaning Establishments	..	..	..	..	..	..	..	..	1	..	..	..	..	1

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged heads and clogged piping.	Miscellaneous.	Total.
Dry Goods Stores	4	..	..	..	..	..	1	1	..	..	..	..	..	6
Dwellings	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Dyeing, Bleaching, Finishing	7	3	1	..	1	2	..	2	..	..	1	1	1	19
Electrical Appliance Mfg.	3	1	2	..	..	..	1	2	..	1	..	1	3	14
Electric Power and Light	2	1	..	..	..	..	..	1	..	..	..	..	..	4
Excelsior Factories	..	..	3	..	1	..	..	..	1	..	..	..	..	5
Fertilizer Plants	2	1	..	..	1	..	..	..	..	..	..	..	..	4
Fibre Products	1	1	1	..	..	..	..	1	..	..	..	1	..	5
Fireworks Plants	..	..	..	..	..	..	..	..	..	2	..	..	..	2
Flax and Linen Mills	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Flour and Grist Mills	10	5	2	..	1	..	1	1	2	6	2	..	2	32
Forge and Smithy	..	..	..	..	..	..	..	1	..	..	..	..	1	2
Foundries	14	..	1	..	1	..	1	1	..	2	1	..	..	21
Fur Works	1	1	..	..	..	..	2	..	..	..	..	..	1	5
Furniture Factories	39	22	10	4	2	..	4	12	15	1	4	4	2	119
Furniture Stores	6	..	..	..	1	..	1	..	..	..	..	..	..	8
Garages	12	..	..	2	1	..	..	3	..	1	..	..	1	20
Garbage Reduction Plants	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Gas Works	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Glass Factories	4	4	2	1	..	..	3	1	..	..	..	..	3	18
Glove Factories	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glue Factories	2	..	..	..	..	..	..	..	1	..	..	..	..	3
Grain Elevators	1	5	5	..	4	..	2	1	1	5	2	..	1	27
Groceries	6	..	1	..	1	..	1	..	1	1	..	..	..	11
Hardware Stores	2	..	..	..	..	..	..	..	..	..	..	..	1	3
Hat Factories	9	4	2	..	1	..	..	2	..	..	..	..	3	21
Hotels—Year Round	2	1	1	..	..	..	1	..	..	..	..	..	..	5
Hotels—Seasonal	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Ice Houses	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Idle and Vacant Property	15	1	..	3	..	..	1	1	..	..	1	1	..	23
Insulated Wire Works	..	2	..	..	..	..	..	..	..	..	..	..	..	2
Jewelry Factories	4	1	..	2	..	..	1	..	..	..	..	..	..	8
Junk Shops	3	..	..	..	1	..	..	..	..	..	1	..	..	5
Knitting Mills—Cop Yarn	1	1	3	..	..	..	..	1	..	1	..	..	..	7
Knitting Mills—Full Process	12	10	6	1	1	..	1	..	..	1	..	1	..	33
Lamp Shade Factories	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Laundries	7	..	1	..	..	..	..	1	..	..	..	..	..	9
Leather Working	1	..	1	..	1	..	..	1	..	..	..	..	1	5
Linoleum Works	..	8	1	..	..	..	2	2	7	..	..	..	..	20
Linseed Oil Works	2	1	..	..	..	..	1	..	1	2	..	2	..	9
Lumber Yards	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Macaroni Factories	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Machine Shops and Works	19	6	1	1	..	1	..	..	1	2	..	2	..	33
Match Factories	2	..	..	..	..	..	..	..	2	..	..	..	1	5
Mattress Factories	12	2	..	1	..	..	..	2	..	..	..	..	..	17
Mercantile (Miscellaneous)	15	6	1	2	..	..	5	..	..	..	4	..	2	35
Metal Workers†	27	18	4	1	1	2	5	4	6	5	2	3	3	81

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged heads and clogged piping.	Miscellaneous.	Total.
Mining Property	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Mirror Mfg.	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Miscellaneous	5	2	1	..	2	..	2	..	5	..	..	..	2	19
Motion Picture Exchanges	..	..	..	..	1	..	..	..	1	..	..	..	..	2
Motion Picture Studios	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Motion Picture Theatres	2	1	..	..	..	..	..	1	..	1	1	..	..	6
Multiple Occupancy	4	1	1	1	1	..	6	..	..	2	..	..	1	17
Munition Plants	2	..	..	1	..	..	..	..	4	2	..	..	1	10
Musical Instrument Mfg.	1	4	..	..	..	..	1	..	..	..	1	..	..	7
Oil Cloth Works	..	..	..	..	..	..	..	1	6	..	..	..	..	7
Oil Clothing Factories	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Oil Refining—Animal	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Oil Refining—Mineral	..	..	..	..	..	1	..	..	..	..	..	..	..	1
Oil Refining—Vegetable	1	..	1	..	..	..	..	..	..	..	..	..	..	2
Packing Houses	6	2	1	..	2	..	..	..	1	1	..	..	1	14
Paint and Varnish Works	3	3	6	..	1	..	3	1	..	3	..	..	..	20
Paper Coating Mills	2	..	..	..	..	..	..	2	..	1	..	..	1	6
Paper Mills	30	26	18	5	2	3	2	10	4	3	3	8	11	125
Paper Working	6	1	..	..	1	..	..	3	1	..	..	1	..	13
Peanut Roasting Plants	..	..	1	..	..	..	..	..	..	..	2	..	..	3
Pencil Factories	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Phonograph Works	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Photo Engraving & Studios	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Picture Frame Mfg.	1	2	1	1	..	..	..	1	..	..	..	..	..	6
Piers and Wharves	..	2	1	..	..	..	..	..	..	..	..	..	..	3
Plumbers Supplies	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Potteries	3	2	1	1	..	..	..	..	..	1	..	..	..	8
Printing and Lithographing	12	5	1	..	1	..	3	1	1	..	3	..	1	28
Prisons	..	..	..	..	1	..	..	..	1	..	..	..	..	2
Public Buildings	..	..	..	..	1	..	..	..	..	..	..	1	..	2
Pulp Mills	12	4	4	..	1	1	1	..	1	1	..	..	2	27
Pyroxylin Plastic Mfg. and Fabricating	4	1	3	1	1	..	2	2	22	6	2	..	..	44
Radios and Accessories	2	..	..	..	..	..	..	..	..	..	..	1	..	3
Railroad, Miscellaneous	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Rayon Mills	..	1	..	..	..	..	..	..	..	..	..	..	1	2
Restaurants	1	1	..	..	..	..	1	..	..	..	..	..	..	3
Rice Mills	..	1	1	..	..	..	..	..	..	..	..	..	2	4
Rolling Wire and Tube Mills	..	1	..	..	1	1	1	..	..	..	1	1	..	6
Roofing Works	3	2	1	1	..	..	1	2	..	1	..	..	..	11
Rooming & Lodging Houses	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Rubber Cloth Factories	2	1	..	..	..	..	..	..	..	..	..	..	1	4
Rubber Reclaiming Works	3	..	1	..	..	..	1	1	2	1	1	..	..	10
Rubber Mills	9	1	..	1	..	..	..	1	7	7	..	1	1	28
Saw and Planing Mills	21	15	7	1	7	1	6	4	8	..	5	1	5	81
Schools—Private	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Schools—Public	1	1	..	..	..	..	1	..	..	..	..	..	..	3
Schools—Trade & Industrial	1	..	1	..	..	..	..	..	..	..	..	..	..	2

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged heads and clogged piping.	Miscellaneous.	Total.
Shipyards	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Shoddy Mills	6	4	7	1	1	3	1	2	..	..	..	..	1	26
Shoe Factories	20	8	3	..	1	1	2	3	..	3	6	..	3	50
Shoe Mfg. Accessories	3	2	..	1	..	..	..	..	..	..	..	..	1	7
Silk Mills	3	2	..	..	..	..	..	..	..	1	..	..	2	8
Smelting and Refining	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Soap Manufacturing	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Stamping & Sheet Metal Wks.	4	5	1	..	1	..	2	1	..	1	2	..	1	18
Starch and Glucose Works	..	..	..	..	..	..	..	..	1	7	..	..	..	8
Sugar Refineries	2	1	..	..	..	..	..	..	..	1	..	..	..	4
Tannery, Class A**	1	1	..	1	..	..	..	..	..	..	1	..	1	5
Tannery, Class B**	9	4	..	2	3	..	1	1	..	..	..	..	1	21
Tannery, Class C**	1	..	1	1	..	..	1	..	..	..	1	..	..	5
Tannery, Class D**	..	..	..	2	..	..	..	..	..	..	..	..	..	2
Tenant Mfg.	57	10	2	5	1	..	4	4	2	1	7	2	3	98
Theatres	4	3	..	..	..	..	..	..	..	..	..	..	..	7
Tobacco Factories	1	1	..	..	..	..	..	..	1	..	1	..	..	4
Tobacco Warehouses	..	.	..	..	..	..	.	..	..	..	1	..	..	1
Trunk Factories	3	1	1	..	..	..	1	..	..	..	1	..	..	7
Umbrella Mfg.	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Wall Paper Factories	..	..	1	..	..	..	..	1	1	..	1	..	..	4
Warehouses	13	4	4	..	2	..	3	2	2	1	..	2	3	36
Waste and Batting Mills	10	4	5	2	2	1	..	2	2	..	..	3	1	32
Waste Paper & Rag Sorting	12	4	1	3	..	..	..	1	..	..	..	..	2	23
Weaving Mills	1	1	2	1	..	..	..	2	..	..	..	..	..	7
Window Shade Factories	..	..	..	1	..	..	..	..	1	..	..	..	..	2
Woodworker, Class A*	14	12	5	1	2	1	2	6	1	3	3	1	4	55
Woodworker, Class B*	10	9	3	3	1	2	1	1	..	3	2	3	..	38
Woodworker, Class C*	7	5	3	..	..	..	1	3	..	1	..	..	1	21
Woodworker, Class D*	3	11	..	1	1	..	..	..	..	2	4	..	3	25
Woodworker, Class E*	7	1	1	..	2	1	2	..	1	..	1	1	1	18
Woodworker, Class F*	2	1	1	..	..	..	..	2	..	..	..	..	..	6
Woodworker, Class G*	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Woodworker, Class H*	..	1	..	..	..	..	..	..	..	..	..	1	..	2
Woolen Mills	22	21	17	2	..	2	4	1	1	..	3	4	6	83
Wool Scouring	..	1	1	..	..	..	1	..	..	..	..	..	..	3
Wool Storehouses	1	2	..	..	..	..	..	..	..	..	..	..	..	3
Worsted Mills	3	4	2	1	..	..	1	..	..	..	..	..	4	15
Total	774	401	205	70	74	27	114	140	134	114	90	70	129	2342

†See note on Metal Workers under Table No. 4.

*See detailed classification of Woodworkers as given in note under Table 4.

**The Tanneries are classified as follows:

Class A. Sole Leather and Belting.

Class B. Upper Leather (Calfskins, Sheepskins, Morocco).

Class C. Patent Leather.

Class D. Skin Mills (Glove Leather).

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How

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When we started our business 34 years ago, it was sufficient for investors to hold *only* stocks and bonds. Hence we were interested in protecting *only* stocks and bonds.

Today, however, an investor is taking great risk in buying only stocks and bonds. **Every conservative business man and investor should today have at least 25% of his funds in real estate, commodities, and other forms of real property.**

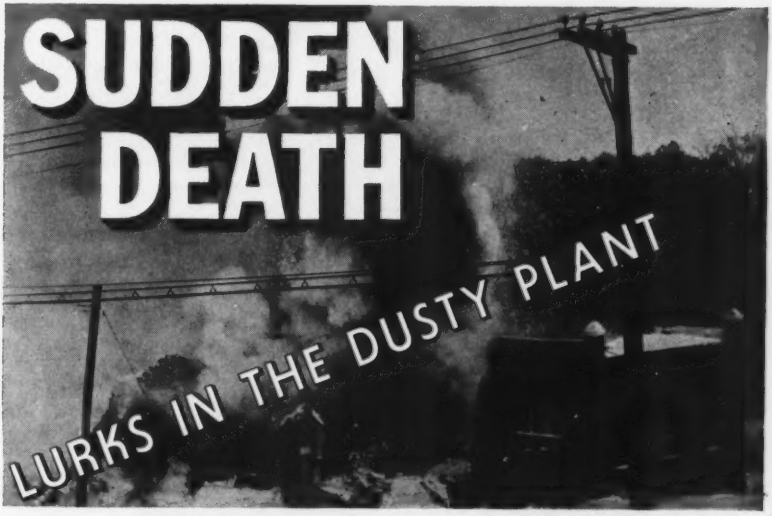
In view of the above, we have bought an interest in companies best prepared to protect buildings, merchandise and assets other than stocks and bonds. We are also anxious to help publications and associations which are striving to reduce fire losses.

For the same reason investors should take more interest in fire protection and back up fire chiefs in their plans and efforts. A good fire department is a good hedge against inflation.

BABSON'S STATISTICAL ORGANIZATION, INC.

By Roger W. Babson, President.

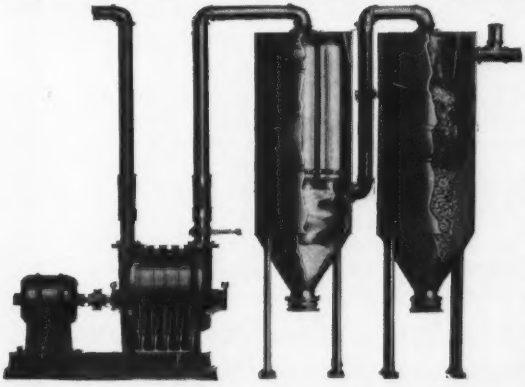
Babson Park, Mass.



REMOVE DANGEROUS DUST DEPOSITS WITH

• HOFFMAN •

HEAVY DUTY VACUUM CLEANING EQUIPMENT



This U. S. Dept. of Agriculture photo shows what happens when accumulated dust, dislodged by a primary flash, ignites and explodes.

Since serious explosions cannot occur where the dust is not allowed to pile up, Hoffman vacuum cleaning systems are an important safety aid in industries having explosive dusts.

Hoffman engineering representatives are always happy to coöperate with fire authorities in promoting safety.

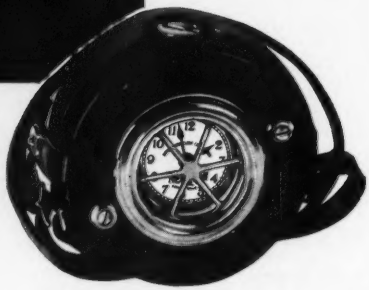
Write for New Illustrated Booklet "REMOVE the MENACE of DUST"

U.S. HOFFMAN MACHINERY CORPORATION

AIR APPLIANCE DIVISION · 105 FOURTH AVE · NEW YORK

DETECTION

The *Surest*



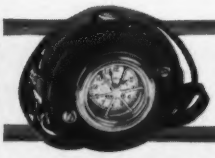
Most Effective Fire Safeguard

CATCH your fire early—before it has had time to gain headway—and the battle is more than half won. But for early detection of fire, you need a thoroughly dependable system of *checking the watchman* . . . of making sure that he is alert to report the existence of a hazard.

WITH the Detex Watchman's system, you will have the simplest and most effective means of checking the watchman's movements. Product of more than 50 years' experience, Detex Watchman's Clocks embody every principle that contributes to reliability, safety and economy.

THERE are more than a dozen models in the complete Detex line . . . each built for a specific need . . . each approved by the Underwriters' Laboratories, Inc., and by Factory Mutuals Laboratory.

DETEX WATCHCLOCK CORPORATION
4163 Ravenswood Ave., Chicago • 31 Beach St., Boston



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INSURANCE AGENTS, FIRE PREVENTION ENGINEERS, EXECUTIVES and BUILDING OWNERS can count on Viking for every assistance pertaining to the use of automatic sprinklers in the solution of fire prevention problems. Inquiries and requests for such assistance, surveys, cost analyses, etc., are always welcomed as an opportunity to be of service in the cause of fire prevention.

If you do not have complete details of Viking Automatic Sprinkler Systems and the Viking Finance Plan which makes it unnecessary for anyone to delay the installation of this needed equipment, write for booklets today. And remember, Viking's Service policy and Viking leadership in the development of automatic sprinkler devices have made Viking one of America's leading manufacturers of sprinkler equipment.

VIKING

AUTOMATIC SPRINKLER SYSTEMS

VIKING COMPANIES:

Atlanta, Ga.-Charlotte, N. C.—Crawford & Slaten Co.
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Cincinnati-Cleveland, Ohio—Viking Sprinkler Co.
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GRAVITY Water Pressure

Provides Dependable Fire Protection

A reserve supply of water in an elevated tank provides dependable fire protection. It is always on hand, ready to flow the instant a fire breaks out. By quenching the flames before they have a chance to gain headway, damage and loss are kept at a minimum.

Elevated steel tanks to meet insurance company requirements are built in a complete range of standard capacities. Our nearest office will be glad to supply information or estimating figures on installations for use in designing fire protection systems.

CHICAGO BRIDGE & IRON COMPANY

Sales offices at BIRMINGHAM, BOSTON, CHICAGO, CLEVELAND, DALLAS, DETROIT, LOS ANGELES, NEW YORK, PHILADELPHIA, HOUSTON, SAN FRANCISCO and TULSA

Plants in BIRMINGHAM, CHICAGO and GREENVILLE, PA.

DUALGUARD Control Takes The Gamble Out Of Water Curtain Operation

BEFORE—Windows protected by Dualguard Automatic Control

AFTER—Windows closed and water curtain in action

By AUTOMATICALLY:

1. **Detecting Fire**
2. **Closing Windows**
3. **Turning on Water**

In the past outside water curtains—*when operated*—have provided properties with mighty effective protection against fires originating in adjoining buildings. The most serious drawback to their effectiveness has been their dependence upon the human element. Unless someone detected the exposure fire, closed windows and turned on the controlling valve manually, the water curtain failed completely.

With its DUALGUARD Automatic Control, Rockwood has taken the gamble out of water curtain operation and provided complete protection to exposed openings.

Operating on the *rate-of-rise* principle of fire detection, DUALGUARD equipment automatically detects heat from an exposing fire long before there is any danger of fire entering the building. Automatically and instantly it closes windows (of either the swivel or swinging type) and then turns on the DUALGUARD Deluge Valve, discharging a protective curtain of water all over the exposed openings. This effective automatic protection is ready for action twenty-four hours of the day—no manual attention whatever is needed.

Write for our booklet Q32.

ROCKWOOD SPRINKLER COMPANY

Specialists In Fire Protection Engineering

WORCESTER, MASS. **CHICAGO, ILL.**

In Canada: WORCESTER FIRE EXTINGUISHER CO., LTD.

On Guard

Fire Alarm Boxes — Sentinels of the Fire Department—are continuously On Guard. In nearly 2000 municipalities—in many instances for more than 60 years—these Sentinels have been protecting the factories, commercial establishments, institutions, and homes near which they are stationed.

Irrespective of the hour or weather conditions, the Sentinel is always On Guard—always ready—to instantly sound the alarm and direct the fire-fighting forces to the scene of fire.

Some of the salient features of the VITAGUARD Fire Alarm System are:

LOW INITIAL COST	EFFICIENCY	NOMINAL MAINTENANCE COST
COMPACTNESS	SIMPLICITY	RUGGED CONSTRUCTION

Write for our new 40-page descriptive catalog.

THE GAMEWELL COMPANY

NEWTON, MASSACHUSETTS

Here's an **ELECTRIC DRIVE . .** *built for Fire Pump Service*

SPECIALIZED CONTROL . .

Westinghouse control apparatus for Fire Pumps conforms to the specifications of the National Board of Fire Underwriters.

Among the advantages of the Westinghouse Dead Front Panel construction are these:

1. No live parts exposed.
2. Can be enclosed in sheet steel cabinet.
3. Double throw oil circuit breaker gives overload protection and permits connection to either one of two sources of power.
4. All operating parts are non-corrodible.
5. Motors and controllers are designed and installed as a unit.

● Men interested in safety appreciate the built-in safety features of Westinghouse motors. They see the sturdy frame construction and rigid end-brackets that insure extra mechanical strength. They know that the over-size bearings mean dependability. They find that Westinghouse dual insulation protects the windings from moisture and dust — and that the Radio Test (exclusive with Westinghouse) gives double assurance of perfect insulation.

Furthermore, they have learned that there is a time-tested Westinghouse motor for every drive with complete control to match. So when you want to be brought up to date on electric drives for Fire Pumps, call in the nearest Westinghouse representative.

Westinghouse

ELECTRIC & MANUFACTURING COMPANY, E. PITTSBURGH, PA.

N.B. SUPROTEX SPRINKLER SYSTEM SUCCESSFULLY WITHSTANDS THE RAVAGES OF FLOODS.

I.E. During the recent floods in the Ohio River and Mississippi River valleys, several Suprotex Systems in this area were completely submerged.

After the flood had subsided every Suprotex System was found to be in perfect working condition.

Fire protection was not impaired during the flood and no repairs were necessary after the flood had subsided.

All Suprotex Sprinkler Systems are automatically supervised.

The supervising agent is air at low pressure and is supplied by a water motivated pump.

For this reason it can not be short circuited as can an electric pump. Water can not damage the pump; therefore, no salvage work is necessary.

The pre-action feature of the Suprotex System permits the sounding of an alarm prior to the opening of a sprinkler head.

Incipient fires are detected by the use of rate of temperature rise devices, "H.A.D.'s," before enough heat is generated to open sprinkler heads.

At such an inopportune time as during a flood, this quick action is invaluable, as approach to structures in the flooded areas is impossible.

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"AUTOMATIC" SPRINKLER CORP. OF AMERICA

YOUNGSTOWN, OHIO

"AUTOMATIC" SPRINKLER RATE OF RISE TRADE MARK CORPORATION OF AMERICA

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HANDBOOK OF FIRE PROTECTION

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The HANDBOOK is the standard reference volume for beginners and experienced men specializing in fire prevention and protection. Read the following list of subjects covered.

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INERT GAS
FOR
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For industries using CO_2, from cylinders or dry ice, for process operations or other puposes, inert gas (approximately 13% carbon dioxide and 87% nitrogen) can be produced by our clients at a cost of approximately 20c per 1000 cu. ft., which is equivalent to 1/6 cent per pound.

The INGAS System is highly effective for the prevention of fires and explosions in mixers, ovens, grinders, dryers, etc., and the safe storage and handling of flammable liquids.

An INGAS unit installed in your plant will provide a continuous supply of inert gas.

The cost of an INGAS unit is frequently recovered from savings in six months to two years.

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Further details and descriptive literature will be forwarded upon request.

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IN THE ENGINEERING OF
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Complete descriptions and illustrations of the items listed above as well as of other Benjamin lighting products for hazardous locations are contained in Bulletin on Explosion Proof and Dust Tight Equipment. A postcard will bring you a complimentary copy by return mail.

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A.D.T. PERFORMANCE 1936

THERE is only one valid test of the value of any protection system—its actual performance record in minimizing losses. The following statistical analysis of A.D.T. performance during 1936 and over the past ten-year period furnishes convincing proof of the effectiveness of A.D.T. protection services in preventing fire and burglary losses.

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Supervisory alarms, indicating impairment of sprinklers . . **110,701**

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Percentage of fire and water damage losses to insurable values of protected properties **13/1,000ths of 1%**

During the past ten years, subscribers to A.D.T. Sprinkler Supervisory and Waterflow Alarm Service have enjoyed 99.97% IMMUNITY FROM FIRE LOSS.

Watchman Supervisory and Manual Fire Alarm Service

Investigations of delinquencies in watchmen's signals **163,953**

Total number of signals supervised was approximately 273,196,560; hence, the watchman patrol efficiency was **99.94%**

Manual Fire Alarms received and responded to **1,435**

Percentage of fire losses to insurable values . . . . . **2/100ths of 1%**

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Burglar and Holdup Alarm Services

Burglars captured as result of A.D.T. alarms **314**

Percentage of losses in attacks on A. D. T. protection, in relation to insurable values **9/1,000ths of 1%**

During the past ten years, A. D. T. Burglar Alarm Protection has given 99.97% IMMUNITY FROM BURGLARY LOSS.

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This ready accessibility is another proof that Grinnell Fire Protection is as complete as this eighty-year-old organization can make it. It is one of the Seven Standards of Superiority which have placed Grinnell equipment on guard over fifty billion dollars worth of the world's property. Our nearest office is always ready to give expert advice on automatic sprinkler requirements.

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